THURSDAY, MARCH 29, 1888.

ELEMENTARY INSTRUCTION IN PRACTICAL BIOLOGY.

A Course of Elementary Instruction in Practical Biology. By T. H. Huxley, LL.D., F.R.S., assisted by H. N. Martin, M.A., M.D., D.Sc., F.R.S. Revised Edition. Extended and Edited by G. B. Howes, Assistant Professor of Zoology, Normal School of Science and Royal School of Mines; and D. H. Scott, M.A., Ph.D., Assistant Professor of Botany, Normal School of Science and Royal School of Mines. With a Preface by Prof. Huxley, F.R.S. (London: Macmillan and Co., 1888.)

THE appearance of the first edition of "A Course of Elementary Instruction in Practical Biology" in 1875 marked an epoch in biological education. The great effects which the doctrine of evolution had been gradually producing in the general system of biological education were then set forth, and widely extended, by means of a clearly written volume containing an account of thirteen types of the organic kingdom. On the appearance of a greatly extended edition of the work, it may not be out of place to say a few words upon the "type-system" of biological education for which the book in its earlier form has done so much. The immense educational success of the work may perhaps be best judged by the fact that, since its publication, an ever-increasing demand has rendered necessary the production of quite a number of new books following the "type-system," and constructed on an identical plan, but dealing with other forms of life.

The important changes in teaching which have followed these publications are seen in the far smaller amount of systematic and classificatory work which is now imposed upon beginners, and its replacement by the acquisition of a thorough knowledge of well-selected types. Remembering that classifications are no more than a condensed abstract of the opinion of the day upon the relative affinities of organic forms, it is clear that no one of the suggested schemes of arrangement can be regarded as final, except as perhaps expressing in the best way the results of a limited state of knowledge. We know that opinion on the subject of affinity has greatly changed in the past, and as long as new facts are revealed by biological research, so long will opinion continue to change in the future. From its necessarily shifting character, and from the fact that the teacher cannot fairly insist upon the accuracy of its conclusions, classificatory biology is eminently unsuited to the needs of a beginner. And there is also another reason, in that classification, if properly taught, is far too advanced a subject to be made an element in early education. If classification is the concise expression of biological opinion, it should nevertheless represent an opinion arrived at after the consideration of *all* the facts and arguments which bear upon the question. The true and only vindication for any suggested modification of existing schemes of affinity must lie in the decided proofs of a better accordance with existing facts. Whoever suggests a modification is under a great responsibility, for, if the alteration is not an improvement, it will certainly be pernicious in adding to our present state of confusion. It is to be hoped that the whole subject will be treated in a more serious spirit in the future than has been accorded to it in the past.

If, then, classification must be dethroned from the high educational position it has held for so long, and which it still maintains to a considerable extent in botanical teaching, what is to be put in its place? Under the type-system a beginner is set to acquire a thorough knowledge of certain central forms of life, each of which is an example of, and a key to, the understanding of an important organic group. At first the types only represent the very largest groups, such as the sub-kingdoms, so that the amount of implied classification is extremely small. As the student progresses, the number of types increases, and the less important organic groups are represented, so that at the end of his course the advanced student finds himself a master of the solid framework of classification, and then the filling in of the details can be carried on in an intelligent and satisfactory manner. It is at this advanced stage of education that advantage can be gained by means of the celebrated "Hunterian system." The comparative study of long series of homologous structures, considered out of relation to the organisms in which they occur, can only confuse the beginner who is not well acquainted with the organisms themselves. But just as the type system prepares the way for, and in fact culminates in, all that is educationally important in classification, so, when a large number of types has been thoroughly learnt, and the varied relations of organ to organ, and of isolated structure to the whole organism, have been grasped in very many instances, then, and not till then, can great advantage be gained by the Hunterian method. And the *extensive* use of this system will be wisely postponed to a very late period; in fact, until the student is beginning to make use of the training which he has received in the wide fields of biological research. The Hunterian system must always form the backbone of a large part of biological research, although it would be most unwise to make it a fundamental part of biological education. It must, however, be conceded that there are certain systems of structures (such as the osteological and dental systems) which especially lend themselves to this mode of teaching, but on account of this very facility such subjects are liable to assume too great a relative importance in biological training.

One incidental, but by no means necessary or even natural, result of the prevalence of the type-system is to be greatly deplored. This result, which is especially found among students of botany, follows from the habit of rejecting the good as well as the bad points in a disused system. Just as the introduction of section-cutting has led to a too great neglect of dissection and the examination of solid structures, so the prevalence of the type-system seems to threaten the existence of the field naturalist and botanist. Those who follow the old, and, upon the whole, the very foolish system of botanical education which a few years ago was the only system taught, have at least one great advantage: they have a keen and intelligent interest in any country walk, while if they possess a little originality and perseverance, they can contribute something towards the solution of some of the most difficult biological problems. But it is not at all uncommon for the successful student of the newer

system to speak of field botany with utter contempt, as a subject unworthy of notice. This is a very unfortunate thing, for there are many most interesting questions which can only be settled by field-observation; and field-observation is in itself a most important, and at the same time a most enjoyable, side of biological training. The same contrast also holds, although to a less extent, on the zoological side. It is much to be hoped that we may be able to correct this great error which has unfortunately attended a healthy, and, upon the whole, highly beneficial educational reaction. It is to be observed that the excellent general descriptions of the types which form so important a feature of the work are in every way calculated to avert this error.

The most striking thing in the revised form of "Practical Biology" is the reversal of the old arrangement, so that the student is now led to begin with a Vertebrate type, and from this to work his way down to the lowest forms of life, and from these, again, upwards to a type of the flowering-plants. There is little doubt that such a change will be met by conflicting criticisms. I believe, however, that the majority of those who have had the widest experience of biological teaching, and especially those who have instructed students in the first use of the microscope, will heartily agree with Prof. Huxley's defence of the alteration, in the preface to the revised edition. The process by which a student first learns to see with the microscope is almost like the education of a new sense-organ suddenly conferred upon a mature organism. We know that under such circumstances it would be a very long time before the impressions conveyed by the new organ could be harmonized with the well-known experiences resulting from the stimulation of other organs. Accustomed to judge of the shapes of objects by their appearance in three dimensions, the student is suddenly provided with a field of vision in which shapes have to be nearly always inferred from the appearance of solid three-dimensional objects when seen under conditions which prevent them from being examined in more than two dimensions at any one time. For it is a long time before the student can accustom himself, by focussing at successive depths, and by making the most of the limited third dimension of depth which the high powers of the microscope provide, to judge accurately of the forms of objects. And the novel conditions under which a student sees with the microscope effectually prevent him from making the best of the impressions he receives. Thus, if the section of a solid object presented the appearance of a circle 1 inch in diameter, and if two other sections at right angles to each other and to the first section presented the appearance of a rectangular figure 3 feet by 1 inch, nearly everyone would readily infer that the shape was that of a cylinder 3 feet long by 1 inch in diameter. But precisely similar data, when presented in the field of the microscope, do not readily lead the student to any definite conclusions as to the forms of objects, and in reality a long course of discipline is necessary in order to make him form any clear conception of the actual shape of the object at which he is looking. I therefore think that it is expedient to begin the course of biological teaching with organisms which only require the use of a microscope for the investigation of part of their structure, and thus to gradually work downwards to the minutest organisms, in which the whole investigation depends upon high microscopic powers. Thus the gradual training in the use of the microscope will proceed parallel with its gradually increasing necessity.

The addition of the earthworm, the snail, and of Spirogyra is a great improvement upon the former edition of the work. If a choice were necessary, the snail is in many respects a more suitable type than the Anodon. In spite of the greater structural simplicity of the latter form, the anatomical details are more difficult to demonstrate by dissection and more difficult to see when dissected than those of the snail. This objection to the Anodon of course only applies to its selection in preference to the snail in the earlier edition; it is in every way desirable that the Lamellibranchs, as well as the Gastropods, should be represented by a well-known type. These newly added types and the additions to the descriptions of those in the previous edition, and to the practical directions, so increase the size of the volume that it contains almost exactly twice the number of pages present in the earlier form of the work. The practical directions given in the appendix appear to be excellent, and to contain in a very small compass an immense amount of information upon the most recent and approved methods. There are a few slips and indefinite statements which should be modified in succeeding editions, which will doubtless be called for at no distant date.

Thus, on p. 383 we are told that *one or two per cent.* of the sugar is unaccounted for in fermentation; but for the rest it is only loosely stated that the *greater part* is resolved into carbonic anhydride and alcohol and *a small part* into glycerine and succinic acid. On pp. 384 and 386 it would be well to represent the numerical proportions of the formulæ by the same method. On p. 462 it is wrongly stated that the cotyledons become green in the type selected. They are in reality hypogeal. On p. 467 no phosphorus is mentioned in the culture solution in which it is stated that the bean-plant will grow. It should read: "potassium phosphate, iron sulphate," instead of "potassium and iron sulphate." In the note on p. 475, "discolour" is used for "decolorize." On p. 483 the student is advised to procure 2 ounces of microscopic slides and half a gross of cover-slips!

Such slight errors can easily be put right, and they would in most cases be detected by the student in reading the book for the first time. They cannot be considered as seriously detracting from so excellent a book, and one which, in the extreme clearness of its style, is so admirably adapted to the needs of the beginner.

E. B. P.

A TEXT-BOOK OF EMBRYOLOGY.

Lehrbuch der Entwickelungs-geschichte des Menschen und der Wirbelthiere. Von Dr. Oscar Hertwig, o.ö. Professor der Anatomie und vergleichenden Anatomie der Universität, Jena. (Jena: Gustav Fischer, 1886.)

THE brothers Hertwig are highly esteemed as original investigators in the field of embryology wherever that science is cultivated. The completion of a systematic work by one of them on the conventional lines of human embryology is therefore a matter of some moment. An

embryologist who bends himself to the requirements of the stereotyped curriculum of human anatomy as demanded alike by German and English directors of medical education, necessarily abandons more or less the consistent scientific treatment of a branch of human knowledge. There is a conventional embryology of the medical school just as there is a conventional anatomy, histology, and physiology, and as there would be a "medical" chemistry, physics, and biology, and a "medical" alphabet, if some professional men in London were to have their own way. Prof. Hertwig has suffered somewhat by submission to these demands. The second half of his work consists chiefly of a description of the development of the various organs, and would more appropriately find its place in that dullest, but most necessary, of treatises—a text-book of human anatomy. The first part, however, is not open to this objection, and even in dealing in the usual way with the development of the organs of the human body in the second half of his work, Prof. Hertwig has managed to bring in a good deal of that scientific interest which is briefly indicated by Goethe's word "morphology." Nevertheless the detachment of the consideration of the mode of origin of the organs of the human body from that of their adult structure and of the structure and development of the same organs in other animals is, in our opinion, an antiquated and mistaken usage, which we are sorry to find so able an author as Prof. Hertwig constrained to follow.

In his first part Prof. Hertwig adopts a more general and truly scientific treatment, and does not distinctly aim at supplementing the work of the topographical anthropotomist. His first chapter is a description of the sexual products, and his consideration is by no means limited to the ovum and spermatozoon of the human species. A comprehensive, though brief, account of the subject with reference to various recent writers is given, and the classification of animal eggs proposed by Balfour is adopted, viz. alecithal, telolecithal, and centrolecithal.

The maturation of the egg and its fertilization are treated in the second chapter, with special reference to the Echinoderma and other Invertebrata, where it has been possible to study this subject with advantage. A third chapter treats of the process of egg-cleavage—the formation by division of the first embryonic cells; a fourth, of the general principles of development—the latter decidedly brief and undeveloped to a degree which is disappointing. Then we come to a chapter on the development of the two primary germ-layers—or on the gastræa theory, as Prof. Hertwig puts it—in which the apparent differences of development of these two layers in various Vertebrata are considered and reconciled, numerous illustrations being introduced into the text, of which a larger number are taken (with ample acknowledgment both in the text and in the special titles of the cuts) from the "Comparative Embryology" of the late Prof. Balfour than from any other source.

The development of the two (parietal and splanchnic) middle germ-layers (cœlom theory) is the next subject of consideration, and is elucidated by a consideration and figures of the process in Sagitta, Amphioxus, Triton, the Mole, &c. The seventh chapter, on the history of the germ-layer theory, is an able and fair statement of the history of embryological doctrine such as every student should be familiar with, and it brings us to the special Hertwigian doctrine of pseudocœl and mesenchyme. The latter is further placed before the reader in the chapter on the development of connective substance and blood. In dealing with the special subject of this book Prof. Hertwig has no occasion to enter upon the question of the pseudocœl—a theoretical conception which, in our opinion, is unnecessary, and not supported by even plausible evidence. The use of the term "mesenchyme" for those cell-elements of the mesoblast layer which lie below the layers immediately bounding the cœlom, and which give rise to connective-tissue and to blood, is, in our opinion, inadvisable. The distinctness which is implied in the use of this term is not, it seems to us, in accordance with the facts of embryology, and we think that embryological appearances may be more correctly stated without introducing the conception of a distinct "mesenchyme," and without postulating a "pseudocœl" in certain Invertebrata, and by adhering to what we may call the "uniformitarian" system, which seeks to explain "pseudocœl" and "mesenchyme" as a special modification of the normal "cœlom" and "mesoblast" respectively—these modifications arising independently under given mechanical conditions in various developmental histories. At the same time, it must be admitted that the attempt to assign a special importance and genetic persistence to "mesenchyme" on the part of the brothers Hertwig has led them to bring many important embryological facts into clear view. The speculations of His as to parablast and archiblast are finally rejected, and a comparatively harmless, though, it would seem, superfluous, theory replaces it.

In the chapter on the primitive segmentation of the body, we come to closer quarters with the ultimate aim of the treatise, viz. the human embryo; and this is followed by chapters on the "Formation of the External Form," and on the "Egg-membranes of Birds and Reptiles," and on the "Egg-membranes of Mammals." These are well illustrated by some of the best amongst already familiar woodcuts (from Balfour, Kölliker, and Turner), and by a coloured plate. At length, in the last chapter of the first portion of his work, Prof. Hertwig brings us to the human interest which has been the motive of all the previous exposition. Here are discussed the "Human Egg-membranes." The medical student is at last rewarded for his patience in wading through the chapters of a scientific treatise, and has the embryo of Allen Thomson, of Coste, and of Krause made clear to him. An excellent account of the structure of the human placenta, accompanied by many woodcuts and by a coloured plate, is given.

Then follows the second "Abtheilung," with its necessarily uninteresting and disjointed account of the development of organs. Whilst recognizing the value, and, in many features, the originality, of this part of the work, we must insist that even so accomplished a writer as Prof. Oscar Hertwig could only do justice to this subject by treating it as part of a comprehensive work on the morphology of Vertebrata, and this the space at his command has not allowed him to attempt. The student will, however, find clear expositions and the latest information on the development of the organs of Vertebrata, with a special reference to the higher Mammalia or man. As an example of the thoroughness with which

Prof. Hertwig has availed himself of the latest inquiries, we may call attention to two figures of the pineal eye of Chameleon and Hatteria, copied from Prof. Baldwin Spencer's memoir in the *Quart. Journ. Micr. Sci.* of last year. Full justice is done by Prof. Hertwig to Mr. Spencer's researches and their significance. We can cordially recommend this text-book of embryology as presenting a decided advance in scope upon the current German treatises on human embryology, one of its merits being that it embodies, among other good things, the teachings and many of the drawings of our "unvergess-licher" Balfour. E. R. L.

A TREATISE ON ALGEBRA.

A Treatise on Algebra. By C. Smith. (London: Macmillan, 1888.)

THIS, the latest text-book on elementary algebra, is intended for the higher classes of schools and for the junior students in the Universities. The title of the book "A Treatise on Algebra," together with the fact that in the preface the book is affirmed to be complete in itself, is likely to convey the impression that the work is more extensive and ambitious in its scope and design than is really the case. In regard to the matter treated of, it covers much the same ground as Todhunter's "Algebra," which it greatly resembles; it differs from it chiefly in a different arrangement of the parts of the subject, and in the introduction of elementary notions of "elimination" and "determinants."

As regards rearrangement of the subject-matter, there is one very gratifying novelty: before making any use of infinite series, the author introduces a chapter in which he discusses some of the tests of the convergency of such series. There is no doubt of the soundness of this course, and for this single reason many teachers would be inclined to prefer this book to others of the same nature.

The principal feature of modern elementary algebraical text-books seems to be that they are written without any reference to the light shed upon the relative importance of different parts of the subject by the progress of algebraical research. A comprehensive survey of the existing knowledge of the science should induce an author to lead the schoolmaster, and not to follow him. It is not too much to expect that a book like the one under notice should bear some traces of what is taking place in the development of the science to which it seeks to introduce a student. It is perfectly true that certain fundamental notions must necessarily be presented in much the same detail relatively in every book, independently of the date of production; but beyond this an author may easily be too conservative in his ideas to be able to compile a work which shall be of the greatest advantage to a student who intends subsequently to continue his reading at a University or elsewhere. Even from the narrow point of view of an examination it would be advisable to give some small indications of the directions in which explorations have been recently taking place, for it is well known that problem papers at the Universities and elsewhere frequently contain matter taken from researches quite recently published. The absence of modern ideas in a book gives a teacher but little opportunity of pointing out to promising pupils the roads to the frontiers of the science. This is the more to be deplored just now, when a premium is placed at Cambridge upon originality of thought in connection with examinations for Fellowships.

As an instance of what is meant, it may be observed that the subject of "reversion of series" is omitted altogether, although it has of recent years come into great prominence. As a fact, for the last three years one of the chief points of interest in pure mathematics has been Sylvester's theory of reciprocants, which are simply reversion invariants; that is to say, those functions of the coefficients of a convergent series which remain unaltered after the process of reversion has been carried out. One has a right to expect, for this reason, that a "Treatise on Algebra" published at the present time should make some allusion to the existence of such a process; in the older text-books, such as Young's "Course of Mathematics," and the "Algebra" published in Chambers' series, the subject received a special heading, whilst in more recent works it appears merely as an example. The present time is not happily chosen for its complete banishment.

"Scales of notation" give place here to "systems of numeration"; this is in accordance with the German "Zahlensysteme," and seems to be a more suitable nomenclature.

The definitions throughout the book are very carefully given. One or two are open to criticism, as in the case of "cyclical order"; this is defined in reference to a "cyclical change of letters." In modern mathematics this process is termed a "cyclical substitution of the letters," and is one of the fundamental ideas of the extensive "theory of substitutions." There seems to be no good ground for shirking the word "substitution," which fulfils requirements of simplicity and suggestiveness, and is the word with which the student will afterwards become familiar. It seems a pity that in the chapter on permutations the opportunity is not taken to introduce a few of the leading ideas of this theory.

In defining "symmetrical expressions" the author states that an expression which remains unaltered by the "cyclical change" is *also* considered symmetrical; the modern definition of a symmetrical function is that it is such that it remains unaltered when any substitution is impressed upon the letters. The expression $(b-c)(c-a)(a-b)$, instanced by the author as being also called symmetrical, is in reality a two-valued (sometimes called an alternating) function, falls under a different (the alternating) "group of substitutions," and is not properly called symmetrical.

In the chapter on theory of numbers—a particularly clear one—the idea of congruences is happily introduced with Gauss's notation. One would have liked to see also some of the notions of Sylvester's "constructive theory of the partition of numbers," as the ideas are very simple and useful, and moreover algebraically expressible most elegantly. The partition of numbers is rapidly becoming a most important part of the "theory of numbers," a fact which must soon be recognized by authors of books of the same scope as this one.

Other portions of the book which are well presented are "factors" (including many of the first notions of the "theory of equations"), "imaginary and complex quantities," and "binomial theorem."

One would like to see "piles of shot" relegated to the examples, as in these days of rifled guns and elongated projectiles it seems an anachronism. The book is logical well printed, and illustrated by the best set of examples that can be found in any book of the same kind.

P. A. MACMAHON.

OUR BOOK SHELF.

My Telescope. By a Quekett Club Man. (London: Roper and Drowley, 1888.)

THIS volume is described by its author as a simple introduction to the glories of the heavens. It is not designed as a guide to the use of a telescope, but simply to give such an account of its teachings as may interest non-astronomical readers. The main features of the various celestial bodies are described, but, for some reason or other, comets are not considered at all. Most of the descriptions are very meagre; thus, nebulæ and star-clusters are disposed of in a page, and that not closely printed; even the sun—"the ruler of our system"—is described in a little over three pages. The scantiness of the information given is the greatest fault of the book.

In the little that the book does contain, many mistakes occur. Thus, the moon is stated to present a marbled or mottled appearance because her surface is unequally refractive (p. 62), and the velocity of light is twice put down as 184,000 miles per second (pp. 46 and 72.)

The illustrations are moderate, and the book has a generally neat appearance. The place it is to occupy in astronomical literature, however, is not very clear, as there are already many cheaper books in existence which contain the same information, and much in addition.

Hand-book of Perspective. By Henry A. James, B.A. Cantab. (London: Chapman and Hall, 1888.)

THIS small book contains the principles of perspective explained in a plain and concise way. The author seems to have taken great trouble to make his meaning as clear as possible, and has spared no pains in getting together a good collection of examples, which are all worked out and accompanied in each case by a diagram.

The examples themselves would form a useful and practical course on the subject, since they are arranged in a progressive order, starting with the projection of a single point, and taking up in turn lines, surfaces, and solids.

Beginners will find this volume very serviceable to them, pictures as well as diagrams being given to illustrate the various positions of planes, lines, &c.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Coral Formations.

IN the last paragraph of my letter which appeared in your issue of the 15th inst. (p. 462), I remarked:—"It is quite reasonable to suppose that the dead coral so dissolved in the formation of lagoons is carried out as material for fresh coral growths."

Mr. T. Mellard Reade, in a letter on the same subject, dated 22nd inst. (p. 488), in criticizing the results published by Mr. Ross's letter of the 15th (p. 462), remarks:—"I believe that at no place on the surface of the globe are such dead shells being supplied at a rate that would even balance this supposed rate of chemical destruction."

Can Mr. Reade give any observations or figures in support of his view of the rate of accumulation of oceanic calcareous deposits?

Laying aside all question as to arithmetical error, and without committing myself to the accuracy of Mr. Ross's figures (or even insisting on my own), as to the amount of dead carbonate of lime dissolved in any given time by sea-water in lagoon formation, but taking it as a fact that it is soluble in a marked degree (as is proved by the experiments made by Mr. Ross and myself), and that coral reefs can only exist in regions under the influence of the great warm tropical ocean currents, then we may expect the waters of coral-bearing regions to contain a greater proportion of lime than is found elsewhere, thus forming the calcareous food for continuous extension of the coral formations.

Of course, a distinction must be drawn between the so-called *dead* and living coral, in thus far that the latter is protected from the solvent action of the sea-water by its vitality, while the former, as referred to in my last letter, is peculiarly susceptible to this influence.

ROBERT IRVINE.

Royston, Edinburgh, March 26.

Professor Rosenbusch's Work on Petrology.

READERS of NATURE interested in the study of petrology will be grateful to Dr. Hatch for his lucid review of Rosenbusch's great work, and those who are not able to profit directly by the German original will be glad of the *résumé* given of the latest classification of the massive rocks according to the views of the greatest living authority on the subject.

A translation of Rosenbusch's book into English is much to be desired. Rich as we are in fragmentary literature on the subject, a leading text-book is still wanting. Dr. Hatch would deserve well of his fellow petrologists if he would give them a translation of the work he reviews so well. There might be room for some cutting down in dimensions, especially in the treatment of the "neo-volcanic" rocks. Rosenbusch himself is conscious that this part of the work is, perhaps, a little overloaded with detail, as he says that with a new structure "the scaffolding is not removed before the house is finished," and possibly a competent translator might consider that a little less scaffolding would still be sufficient.

There will no doubt be more or less difference of opinion among authorities as to the correctness of the views which have governed Rosenbusch in his system of rock-classification, especially on one or two points. But none will deny that this classification, with the immense research and study accompanying and supporting it, fully given to the student in this latest work, are a splendid achievement.

Dr. Hatch does well, especially in the interest of younger workers in petrology, to insist on the purely arbitrary nature of *any* system of classification, so far as the separate "rock-types" are concerned; such types passing more or less gradually into others, on either side of them, in all cases. Rosenbusch himself points this out, but a further emphasis of the warning was well in place.

In working with a large text-book like the one in question, with its minute treatment of small details, the student is apt to neglect this consideration of the passage of one rock into another, or at any rate to devote too little attention to it. Nothing, however, could be a greater safeguard to him in this respect than to make for himself a tabular arrangement of Rosenbusch's system, so that the eye can follow in a moment the relationships of the different rock-types to each other. I think it is a pity that such a map, as it were, does not accompany the book. The attentive study of it would not only much assist the worker in his detailed use of the book, but would also greatly aid the beginner to "keep his head level" and steer clear of the sad pitfall of going in too much for "pigeon-holes."

Perhaps an outline table of this sort, which I inclose, may be of a little use to some of your readers, if only to give a compact view of Rosenbusch's classification and of how he connects the main rock-types in series through the four divisions of plutonic rocks, dyke-rocks, palæo-volcanic rocks, and neo-volcanic rock.

An amplified table on the same model, with the various

leading sub-types under each main type, is what I have tried to indicate. Such a table makes clear at once not only the passage of, say, syenites into trachytes, diorites into andesites, but also that of trachytes into andesites, andesites into basalts, &c., &c.

Plutonic Rocks	Dyke Rocks	Effusive Rocks	
		Palæo-volcanic	Neo-volcanic
Granites	Muscovite-Granite (Aplite) Granite-Porphyries	Quartz-Porphyries	Liparites Pantellerites
Syenites	Syenite-Porphyries Syenitic Lamprophyres	Quartzless-Porphyries	Trachytes Basic Pantellerites
Elæolite Syenites	Elæolite-Porphyries		Phonolites Leucitophyres
Diorites	Diorite-Porphyrites Dioritic Lamprophyres	Porphyrites	Dacites Andesites
Gabbros and Norites		Augite-Porphyrites and Melaphyres	Basalts
Diabases			
Theralites			Tephrites Basanites
Peridotites		Pikrite-Porphyrites	Limburgites Augitites
			Leucite Rocks
			Nepheline Rocks
			Mellilite Rocks

A student who has attempted, with plenty of good sections to work on, to draw a definite line between trachytes and andesites, or augite-andesites and basalts, will probably not easily again fall into the error of believing in hard-and-fast types!

Dr. Hatch has at once indicated two main points which will strike petrologists as open to criticism in Rosenbusch's system: the "dyke rocks," and the subdivision of the effusive rocks into "palæo-volcanic" and "neo-volcanic." With regard to the former it deserves to be pointed out that it has not been found possible to classify any representatives of the diabases and gabbros under the head of dyke rocks at all; and one feels that very considerable force has been used, in some other cases, in order to get the rocks under this division into their proper "pigeon-holes."

Something of the same sort of strain and artificiality is felt in some cases with regard to the two divisions of the effusive rocks, and here again it is, perhaps, the equivalents of the diabases and gabbros which most strongly exemplify this feeling—viz. the augite-porphyrites and melaphyres, and the basalts.

Many passages, in several parts of the book, show how fully conscious Rosenbusch is of the weak places there are in his system, as there must always be weak places in every system in a young and rapidly growing science like microscopic petrology. One does not know which most to admire—the wonderfully wide research and knowledge, and the skill and painstaking care and labour, with which the system of classification has been evolved out of the great amount of material to hand, or the great modesty with which it is presented to us.

It will be a thousand pities if a translation of the book does not before very long find its way into the hands of all English-speaking petrologists. A. B.

Manchester, March 19.

"The Mechanics of Machinery."

ANY errors—or what seem such—in a work of so high character and repute as Prof. Kennedy's "Mechanics of Machinery" may be conveniently noticed in NATURE; and therefore no further reason need be offered for the following remarks.

(1) "If, then, a body is moving with a linear velocity of v feet per second about a centre (permanent or virtual) at radius r feet, it is undergoing a radial acceleration of $\frac{v^2}{r}$ foot-seconds per second, and the centrifugal force corresponding to this acceleration will be $\frac{v^2}{r}$ pounds per unit of mass . . . ." (p. 228).

Surely there is some confusion here between the virtual or instantaneous radius, and the radius of curvature; for it is of course the latter which indicates the radial acceleration.

It has always seemed to me that the common expression that a body is turning "about," or, as Prof. Kennedy sometimes puts it, "round," its virtual centre is very apt to mislead. All that we are entitled to say is that at any given instant one point is at rest; and that all other points are moving in directions at right angles to the lines joining them with that point, and with velocities proportional to those lines. This being true also in the simple case of motion in a circle we are apt to use the same language to express it, with the inevitable suggestion of the *curvature* being in correspondence. It need not be said that the curvature may be zero (as when a circle rolls inside one of twice its diameter); or that it may be *away from* the centre (as when the former circle is more than twice the diameter of the second). The beginner would find it hard to realize the latter case when he has been taught to speak of the body "turning round" its virtual centre. I do not know that any better description can be adopted, but it ought to be introduced with emphatic cautions that it is merely a convenient device of description. In any case it seems to me that the old term "instantaneous centre" is more likely to keep the truth before us than the "virtual centre" preferred by Prof. Kennedy.

(2) In a series of interesting discussions about train resistance, the following passage occurs: "The brake resistance is 1200 pounds, but it has to be overcome through a distance π times as great as that moved through by the train as a whole . . . . ;" this brake resistance having been described above as "the frictional resistance at the periphery of each wheel."

I cannot follow this. Surely if the circumference of the wheel be x feet, by the time the train "as a whole" has run over a rail-length of x feet, the brake has slid over a wheel-circumference of x feet also.[1]

This need hardly have been noticed, but that the examples seem always very carefully chosen, not as fancy problems, but as being in accordance with practical experience. Either, therefore, the common impressions as to the time and distance requisite for stopping must be wide of the mark, or the value assumed, in this and a number of other examples, for the brake resistance, must be about three times too small.

(3) "If, for instance, the brakes had not acted promptly, and had been put very hard on at the end, the velocity and acceleration curves might have been as dotted, when the maximum acceleration occurs almost at the end, a state of affairs very uncomfortable for the passengers" (p. 205).[2]

Is this so certain? I mean, is there any reason to suppose that a sudden change of *acceleration*, not of *velocity*—for of this there is no question with any conceivable brake system—would be felt as disagreeable?

The question must, one would think, have often presented itself to speculative and scientific engineers; but as I do not remember to have seen it discussed one would like to get their opinion on the point. The way it strikes me is this. We cannot practically suppose the acceleration *put on* instantaneously, for the brake needs time to work; but we can get as near as Nature allows to the instantaneous when it is *taken off*. That is, if the brakes are left on to the end, the velocity continues to diminish

[1] In the *Errata* we are told to omit this passage; but as the premises and the conclusion, between which it formed the necessary connection, are left unaltered, the need for it is as great as before. How else, but by such an inference, can the conclusion be reached?

[2] The curve of velocity here is a parabola, or nearly so, representing (on a distance scale) a nearly constant "acceleration," with a constantly decreasing velocity.

down to zero, and at the instant the train comes to rest the constant (negative) acceleration abruptly ceases.

How would this show itself in our feelings? If I were sitting with my back to the engine, leaning against the wall of the carriage, I should feel a slight mutual pressure between my back and the wall. This would remain constant to the end, and then abruptly cease. It would be but slight (for any possible brake acceleration must be but a small percentage of that of gravity) in comparison with that which we feel when we lie down. Would its abrupt termination—there being by supposition no sudden change of velocity—be really unpleasant?

To take a fanciful example. If, as I sit in my chair, gravity were suddenly annihilated (for me): I should note the cessation of pressure, and, in so far as my body is elastic, there would be some change of conformation. The pressure in the blood-vessels would also be changed, &c. But, dealing with even such a large acceleration as this, would the instantaneous change be at all comparable with that of a sudden trifling change of *velocity*?

Anyone who has been in a lift at the moment the cord broke might be able to tell us what all this feels like: but he must be careful to distinguish between the sensations due to the first moment of his passage from those due to the last.

Caius College, Cambridge. J. VENN.

The Definition of Force and Newton's Third Law.

PERHAPS your correspondents now engaged in discussing the value of dynamic terms could extend the range of their controversy a little, and deal with a subject of great importance which no text-books touch.

It seems to me that the definition of force as that which causes or alters motion is not reconcilable with Newton's law which asserts that every force is always opposed by an equal and opposite force.

How can a force opposed by an equal and opposite force perform work, or affect the motion of anything? We have here either a fallacy or an indefiniteness, and the matter is worth clearing up because it incessantly worries students who think.

March 23. NEMO.

Green Colouring-matter of Decaying Wood.

ANYONE who lives in a fairly wooded part of the country must be familiar with the fact that at certain stages of decay fallen branches of trees are often to be observed among the dry forest-litter coloured more or less through their tissue with various shades of green. After an examination of thin sections with the microscope, I am unable to trace this to any saprophytic organism. Chemical analysis, on the other hand, reveals the presence of *iron* as the base of the green colouring-matter (using fairly strong nitric acid as a solvent), which—so far as the evidence at present goes—seems to be some organic salt of iron, the organic acid being probably furnished by the slow decomposition of the woody tissue. In the hope that some further light may be thrown on the origin of the green-colouring matter of many Tertiary green earths, I would ask the favour of being allowed to solicit references to any foreign literature of the subject with which any of the numerous readers of NATURE may be acquainted.

A. IRVING.

Wellington College, Berks, March 17.

THE HITTITES, WITH SPECIAL REFERENCE TO VERY RECENT DISCOVERIES.[1]

I.

OF late much has been said concerning the Hittites, and, as might be expected in relation to such a subject, there have been fanciful hypotheses and wild vagaries, repugnant alike to the scientific method and the scientific spirit. But most persons, one would suppose, who have given serious attention to the subject, must have become convinced that there is a great vacancy in that map of the past which ancient history presents. Mighty kings, dynasties enduring, it may be, through thousands of years, great peoples who had made no slight advance in civilization, have passed away without leaving any chronicle equal even to those which were extant concerning Egypt and Assyria before the decipherment of the hieroglyphics and the cuneiform characters. The recent change in public opinion concerning the Hittites is not due merely to the discovery of monuments and inscriptions in various parts of Asia Minor: a large proportion of these had been known to exist for a considerable time, some for a very long time. It must be referred rather to the recognition of an identity or similarity of character in these monuments and inscriptions. And thus has arisen the idea of an empire stretching from the Euphrates to the Ægean Sea. It is, however, doubtful whether—if we use the word "empire" in such a sense as we employ it when we speak, for example, of the Empire of Russia or the Empire of China—there is any ground for believing that a Hittite Empire ever existed. Most likely there were in Asia Minor many States, or even single cities, which were usually to a great extent independent, and the peoples of which were not, perhaps, altogether homogeneous in race, but which, under pressure of the necessities of war, formed a federation. This view accords with the passages in the First and Second Books of Kings which speak of the "kings of the Hittites" (2 Kings, vii. 6) and of "all the kings of the Hittites" for whom Solomon's merchants brought up out of Egypt chariots and horses (1 Kings, x. 28, 29). The testimony of these passages in relation to the greatness of the Hittite peoples has been till recently but little regarded.

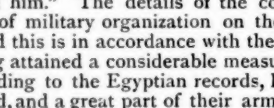
That the Hittites thus spoken of in the Old Testament are to be identified with the Khita of the Egyptian monuments, and with the peoples of the land of Khatti in the Assyrian records, is coming out more and more clearly; and as an especial link joining together the peoples thus designated by the Egyptians and Assyrians may be mentioned the city of Carchemish. Holding the Upper Euphrates, the Hittites stood between the Egyptians and the powerful and warlike peoples of Mesopotamia. On a superficial view this may seem not to be the direct route from Egypt to Mesopotamia; but to lead an army by the apparently more direct way across the Syrian desert would have been difficult or wholly impracticable. Moreover, it would not have been easy for an army to make the passage of the Euphrates towards the mouth of the river. But by the upper course of the Euphrates, at or near the site of Jerablûs, the river could be crossed with comparative ease. On the site of Jerablûs (from which the British Museum obtained a few years ago most of the Hittite monuments now in the collection) stood in all probability the renowned city of Carchemish. This identification, attributed to Mr. Skene, was accepted by the late Mr. George Smith, who visited the place shortly before his death. It was this city of Carchemish (not to go back further in Assyrian or Babylonian history) of which Tiglath-Pileser, about 1100 years before Christ, says, "The city of Kargamis, belonging to the country of the Khatti, I smote in one day. Their fighting-men I slew, their movables, their wealth, and their valuables I carried off." He records further that he pursued the portion of the Hittite army which fled; that he crossed the Euphrates in boats covered with bitumenized skins; and that he returned triumphantly to his city of Ashur. The conflict between the Hittites and Assyrians was, however, destined still to continue for 400 years, during which time, though repeatedly sustaining defeat, the Hittites made again and again a determined resistance. It was the fortune of Sargon to end the conflict by the capture, in 717 B.C., of Carchemish and its king, Pisiris.

Previous Egyptian monarchs had engaged in conflict with the Hittites with more or less conspicuous success; but it was the renowned son of Seti, the great Rameses II., about 1330 B.C., whose war with the Khita, and the great battle fought with them at Kadesh, appear to have

[1] Based on Lectures delivered by Mr. Thomas Tyler at the British Museum in January 1888.

been regarded as the most honourable and glorious. This, at any rate, would seem likely, from the care manifested in transmitting to posterity a record of these achievements. The Egyptian laureate, Pentaur, no doubt with a measure of poetical licence suited to his office, described how the Hittite commander, Khita-sar, summoned to the war all the peoples from the uttermost ends of the seas, countless in number, covering mountains and valleys like grasshoppers; and among this multitude were the people of Carchemish. In order that the "sinews of war" might not be deficient, Khita-sar "had not left silver nor gold with his people; he had taken away all their goods and possessions to give to the people who accompanied him." The details of the conflict show a high degree of military organization on the part of the Hittites; and this is in accordance with the position that they had long attained a considerable measure of civilization. According to the Egyptian records, however, they were defeated, and a great part of their army slain, some perishing in the waters of the Orontes, on the banks of which river the battle was fought. It seems sufficiently clear, however, that the Hittites, and "the miserable king of the hostile Khita," as Pentaur calls him, had proved themselves no contemptible foes, and that, defeated though they may have been, their power was very far from being entirely broken. This may be gathered from the treaty of offensive and defensive alliance which was subsequently ratified between Rameses and the Khita. There was to be continual peace and brotherhood; no hostility was ever to arise. Rameses, moreover, eventually married the daughter of the Hittite chief, and made her his queen.

The great sculpture and painting on the walls of the temple at Abu-Simbel, far up the Nile, which represents the war of Rameses with the Khita, and the battle of Kadesh, gives in a point of detail an interesting piece of evidence tending towards the conclusion that the Khita are to be identified with those who sculptured the monuments now known as Hittite. There are depicted on two at least of the monuments in the British Museum, which were obtained from excavations at Jerablûs or Carchemish, heads of kings or other persons in authority bearing the appendage known as the "pig-tail." We are accustomed



1. 2. 3.

FIG. A.—1. "Pig-tail" from Jerablûs monument in the British Museum. 2. Type of head at Eyuk. 3. Head of Khita warrior at Abu-Simbel (after Rosellini).

to associate the "pig-tail" especially with the Chinese, though they derived this mode of head-dress from the Manchu Tartars at a comparatively recent period. And, *primâ facie*, one is not unnaturally inclined to regard the pig-tail on the Jerablûs monuments as having a connection more or less identical—that is to say, a connection with the Manchu Tartars or with some cognate people. The sculptors of the Jerablûs monuments seem to have done their best to show that the pig-tail is a veritable lock of hair, and not a mere appendage of the tall conical cap. On what has been called the doorway inscription in the British Museum, to show that hair is intended, the "pig-tail" is ribbed or marked across; and there is a similar transverse marking of the hair of kings and other persons on the Assyrian monuments. Turning to the great painting at Abu-Simbel, already alluded to, we find that a certain proportion of the Khita warriors are represented as wearing the pig-tail, though this is not the case even with all the kings and princes. A prince, for example, who has fallen into the water of the Orontes, is destitute of this ornament. And even the great Khita-sar, the commander of the Khita, though he had the conical cap, does not seem to have worn the pig-tail.

The indications are clear that the pig-tailed heads on the Jerablûs monuments represent, in accordance with what has been already said, kings or persons of superior dignity. Other heads with ordinary long hair may be taken to be those of persons of inferior rank—subjects or servants. And, in the Abu-Simbel painting, the pig-tailed riders in the chariots are evidently the superiors of the persons beside them wearing long hair. Generally the soldiers with long hair act as shield-bearers or charioteers, while it is the chief warrior who wears the pig-tail.

On two, also, of the bas-reliefs at Eyuk, a place in Asia Minor not far from the River Halys, the wearing of the pig-tail is clearly represented, though the superiority or predominance of the wearers is not equally apparent. On one bas-relief there are six figures, apparently in marching order, all of which probably bore originally the pig-tail, though the monument is now much decayed. It is not, however, very difficult to make out a remarkable Mongolian type of countenance. This is especially to be seen in the figure of a man ascending steps or a ladder, as represented by Perrot and Guillaume ("Exploration Archéologique de la Galatie," plate 62).

Having regard, however, to the monuments from Jerablûs in the Museum, and to the Egyptian painting at Abu-Simbel, the inference seems pretty clear that the wearers of the pig-tail had gained the predominance in some of the Hittite cities, and that they were of a stock different from that of the general population in those particular cities. With the evidence which we at present have, it would be hazardous to say that this was the case in all the Hittite cities. Indeed some facts already alluded to render such a general conclusion extremely improbable.

The general Hittite population was most likely in great part, or principally, Semitic.[1] It is in accordance with this view that their great deity was Set or Sutech—a name repeated ten times, in connection with different cities, in the catalogue of the gods of the land of Khita, in the treaty with Rameses—and the treaty makes mention also of Astartha, or Ashtoreth, as "of the land of Khita"; and here, again, we have unquestionably a Semitic deity. Moreover, of the worship of Ashtoreth there is other important evidence on the Hittite monuments. There are, besides, names of Hittite cities which are unmistakably Semitic; as Carchemish, which can scarcely be explained otherwise than as meaning "the fortress of Chemosh." Then there is Pitru, or Pethor, as well as Hamath and Kadesh. Looking at these names alone, there would be a strong *a priori* probability that the speech of the inhabitants of these cities was Semitic. No doubt there are many names of Hittite persons and places, mentioned in the Egyptian and Assyrian records, with respect to which we must adopt the opinion of Brugsch that they are at least not purely Semitic.[2] The designation of the leader of the Khita or Hittites, Khita-sar, has, it is true, the word *sar*, which is Semitic for "prince," but the Semitic order is reversed. In a purely Semitic formation we should not expect to find "Khita-prince," or "of-the-Khita prince"; the order would probably be the same as ours, "Prince of the Khita." The presence of those wearers of the pig-tail suggests an explanation of the order of the words in Khita-sar, and of

[1] M. Perrot observes:—"Or les Cappadociens, qu'Hérodote appelle Leuco-Syriens ou Syriens blancs, étaient de race sémitique; c'est un fait attesté tout à la fois par les historiens et par le témoignage des médailles, qui nous montrent encore un idiome sémitique parlé au-delà de l'Halys, de Tarse à Sinope, dans la cours même du quatrième siècle avant notre ère" (Perrot et Guillaume, *op. cit*, vol. i. p. 335). Mr. Pinches, of the British Museum, tells me that several Cappadocian tablets in the cuneiform character have been discovered. Six of these are in the Museum, and one at least is in part Semitic. The others, together with one in the Bibliothèque Nationale, at Paris, have, with one exception, hitherto resisted the attempts at decipherment which have been made.

[2] "History of Egypt," English translation, vol. ii. p. 5.

various other forms, as the Hittite names Pais and Pisiris, and of names ending with the termination *-beg*, as Sathekh-beg, or Suki-beki. The wearing of the pig-tail agrees with the reversal of the order in Khita-sar, since, in accordance with the Mongolian idiom, the order would be reversed; and, having regard to such names as Genghis, Usbeg, &c., there is no difficulty in accounting for the ending in Pisiris and Sathekh-beg.

We may come, then, rationally to the conclusion that men of a race cognate with the Mongols gained the supremacy in some of the Hittite cities; that this ascendancy had its influence on some proper names, and perhaps on other words, but did not change the language of the entire population. If this had been previously Semitic, it remained such. The wearers of the pig-tail did not require their subjects to arrange their hair in the same fashion; and, similarly, they did not attempt to change their language. If they had made the attempt, it would in all probability have been abortive.

Allusion has been made to the rock-sculptures found at various places through the length and breadth of Asia Minor. Among these, pre-eminence must certainly be assigned to the very remarkable bas-reliefs at Boghaz-Keui, in Cappadocia, a place not far distant from Eyuk, already mentioned, and also near the Halys. Here, where there was, no doubt, originally a chasm or rift in the rocks, closed at one end, the surface of the rocks seems to have been prepared, and a sort of gallery formed. On the two sides of this gallery some sixty or seventy figures have been executed, forming what may be regarded as two processions, which meet on a grand tableau, engraved on the rock at the closed end, in the persons of a male and female figure of much greater height than the rest. Each of these figures seems to be presenting to the other a sort of flower or plant, an arrangement similar to what is to be seen on a seal very lately discovered at Tarsus. The male figure, in the Boghaz-Keui bas-relief, stands on the bended heads of two persons clad in long robes, who in all probability are priests. Each of these figures wears, like that above, a pointed cap, and the curious triangular ornamentation of the skirts of their dresses is very noticeable. The principal male figure has in his hand a sceptre terminating in a ball, and beside him is an animal, said to be a bull, also wearing a pointed cap. If the animal is really a bull, it was probably introduced partly to show by con-

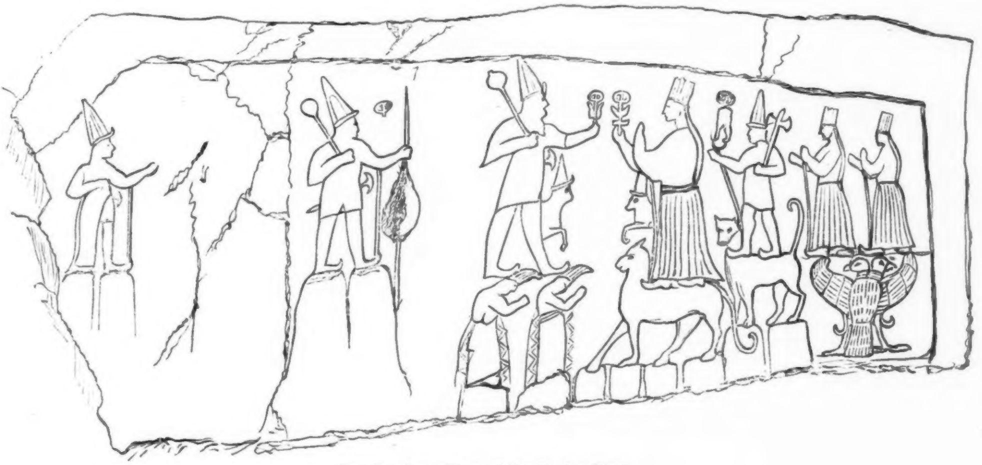
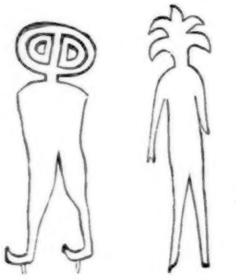


FIG. B.—Central bas-relief at Boghaz-Keui.

trast the relatively gigantic size of the male figure standing beside it. Behind the principal figure is a long procession of some forty other figures, nearly all of which are evidently male, and among them are two winged deities, one of these being apparently the same god that is, or was recently, to be seen on a bas-relief at Jerablûs. Twelve figures in the extreme rear are in the act of running. They have conical caps, but differ from the sceptre-bearing kings, if we may so call them, at the front, in the grand tableau. These hindmost figures we may take to be common soldiers. It is, however, a procession of female figures to the right of a spectator in the rock-gallery to which the principal interest belongs. Each of these, from the more gigantic female figure in the grand tableau to the twentieth in the rear, has on her head a tall cap or crown. This is the so-called "mural crown." In its origin this mural crown probably represented the wall of a city; and the figure bearing it was most likely originally the personification of a city. If, however, this was its origin, it must have become in time diverted from its original use; and, having regard to the male procession, it cannot be regarded as likely that each of the female figures represents a distinct city. Each of these figures has what has been called a *bâton* or stick. But it is very noticeable that this so-called *bâton* is in most, probably in all, cases distinctly curved; a fact which—so it seems to me—probably denotes that it is an unstrung bow. If this is the case, we shall then have a procession of female warriors. Their attire in other respects would be consistent with the idea of their being priestesses, and, if so, the combination of warrior and priestess would precisely accord with one well-known view of the Amazons. It is remarkable, too, that the place where these sculptures are found is not very far from the locality by the River Thermodon and the Black Sea, which the Greeks assigned as the head-quarters of the Amazons. What, then, is the general view to be taken of this remarkable bas-relief? Some have thought that the whole idea is religious, and that at least the two figures meeting in front of the two processions are deities. But how is it, then, that these figures are without wings, seeing that there are winged deities in the male procession? Their mere greatness of size would not show that they are other than persons of kingly and queenly rank. I should not think, however, that the artists who executed this sculpture were commemorating any contemporary event. Probably they were concerned with some notable event in the past, when a king and queen met to ratify an

alliance, or for some other purpose. If the Amazons are, as is commonly thought, merely legendary persons, having no real existence, this sculpture at Boghaz-Keui may yet be looked upon with probability as tending to show that, in what may be called their own country, the story of these female warriors was believed. On the whole, it seems likely, in view of the evidence of this bas-relief, that the story rests on a substantial basis of truth. There is also, I may add, in the Hamath inscriptions, what looks very much indeed like the indication of female warriors armed with club and sword.[1]

Before passing from this Boghaz-Keui sculpture (other interesting bas-reliefs which are there I cannot now discuss), I must refer to the fact that in several instances curious symbols are held in the hands of several of the personages in the processions, or are placed near them. The floral or vegetable symbols held in the hands of the principal personages are surmounted by a remarkable oval figure. This oval object Prof. Sayce regards as a symbol of deity; and the vegetable or other figure beneath he takes for the name of a god. That the name of a god could be indicated by characters such as these seems to me a thing not easily credible; and the inscriptions give very strong reasons for regarding the oval object as a symbol denoting, not deity, but a city.[2] The more probable view seems to be that these figures surmounted by the oval object are the distinctive standards



1. 2.

FIG. C.—1. Standard, with symbol of "city" at Boghaz-Keui. 2. Mandrake after Visconti ("Iconographie Grecque") from manuscript of Dioscorides.

of cities. Unfortunately in the places where these standards occur the sculptures have suffered much from the effects of weather and of time; and the question has been complicated by the differences in the representations given by M. Texier and by MM. Perrot and Guillaume. The representations of the latter, based to a great extent on photographs, are no doubt by far the more accurate. M. Perrot seems to have thought that all these symbols are related to the mandragora or mandrake, a view which I venture to think very improbable. The oval symbol, with its curious marking, is certainly not the fruit of the mandrake, which is round and pendent, not oval and erect. But there is one place in the grand tableau where, I should say, the mandrake is clearly intended.[3] One of these is the symbol borne by the male figure immediately behind what I may call the queen. This figure bears in his hand, as a standard, the mandrake root with the ends turned up into feet. The ancients not only attributed aphrodisiacal and fecundating properties to the mandrake-root, but they also considered that it resembled the body of a man. Pythagoras is said to have spoken of the mandrake as "of human shape." And the difficulty about the feet was easily got over by a little manipulation.[1] There may possibly be some connection between this single male figure with the mandrake standard behind the queen, and what was said by the Greeks as to the relations of the Amazons with the males of a certain city separated from them by a mountain. I should add that the male figure immediately behind the king has the pole of the standard and the oval above, but the intervening figure is gone. It is probably still the standard-pole with the last figure to the reader's left in the central tableau. And possibly, too, at Karabel, the Hittite characters are to be understood as depicted on a standard.

(*To be continued.*)

[1] Under an indication of sex scarcely to be mistaken, is an arm with a hand grasping a club and a sword or dagger.

[2] This was, I believe, the view of Prof. Sayce, before he recognized the Hittite character of the Boghaz-Keui sculptures.

[3] There is evidence also equally clear on the other bas-reliefs at Boghaz-Keui which I do not here discuss.

[1] In the drawing in a manuscript of Dioscorides, of the fifth century, in the library of Vienna, and in Visconti's engraving, the mandrake root is grasped by a female figure. An artist, who is painting the mandrake, is actually accentuating the feet.

TIMBER, AND SOME OF ITS DISEASES.[2]

VI.

IF we turn our attention for a moment to the illustrations in the first article, it will be remembered that our typical log of timber was clothed in a sort of jacket termed the cortex, the outer parts of which constitute what is generally known as the bark. This cortical covering is separated from the wood proper by the cambium, and I pointed out (p. 184) that the cells produced by divisions on the outside of the cambium cylinder are employed to add to the cortex.

Now this cortical jacket is a very complicated structure, since it not only consists of numerous elements, differing in different trees, but it also undergoes some very curious changes as the plant grows up into a tree. It is beyond the purpose of these articles to enter in detail into these anatomical matters, however; and I must refer the reader to special text-books for them, simply contenting myself here with general truths which will serve to render clearer certain statements which are to follow.

It is possible to make two generalizations, which apply not only to the illustration (Fig. 20) here selected, but also to most of our timber-trees. In the first place, the cortical jacket, taken as a whole, consists not of rigid lignified elements such as the tracheids and fibres of the wood, but of thin-walled, soft, elastic elements of various kinds, which are easily compressed or displaced, and for the most part easily killed or injured—I say for the most part easily injured, because, as we shall see immediately, a reservation must be made in favour of the outermost tissue, or cork and bark proper, which is by no means so easily destroyed, and acts as a protection to the rest.

The second generalization is, that since the cambium adds new elements to the cortex on the inside of the latter, and since the cambium cylinder as a whole is travelling radially outwards—*i.e.* further from the pith—each year, as follows from its mode of adding the new annual rings of wood on to the exterior of the older ones, it is clear that the cortical jacket as a whole must suffer distension from within, and tend to become too small for the enlarging cylinder of rigid wood and growing cambium combined. Indeed, it is not difficult to see that, unless certain provisions are made for keeping up the continuity of the cortical tissues, they must give way under the pressure from within. As we shall see, such a catastrophe is in part prevented by a very peculiar and efficient process.

Before we can understand this, however, we must take a glance at the structural characters of the whole of this jacket (Fig. 20). While the branch or stem is still young, it may be conveniently considered as consisting of three chief parts.

(1) On the outside is a thin layer of flat, tabular cork-cells (Fig. 20, *Co*), which increase in number by the activity

[2] Continued from p. 279.

of certain layers of cells along a plane parallel to the surface of the stem or branch. These cells (*C.Ca*) behave very much like the proper cambium, only the cells divided off from them do not undergo the profound changes suffered by those which are to become elements of the wood and inner cortex. The cells formed on the outside of the line *C.Ca* in fact simply become cork-cells; while those formed on the inside of the line *C.Ca* become living cells (*Cl*) very like those I am now going to describe.

(2) Inside this cork-forming layer is a mass of soft, thin-walled, "juicy" cells, *pa*, which are all living, and most of which contain granules of chlorophyll, and thus give the green colour to the young cortex—a colour which becomes toned down to various shades of olive, gray, brown, &c., as the layers of cork increase with the age of the part. It is because the corky layers are becoming thicker that the twig passes from green to gray or brown as it grows older. Now these green living cells of the cortex are very important for our purpose, because, since they contain much food-material and soft juicy contents of just the kind to nourish a parasitic fungus, we shall find that, whenever they are exposed by injury, &c., they constitute an important place of weakness—nay, more, various fungi are adapted in most peculiar ways to get at them. Since these cells are for the most part living, and capable of dividing, also, we have to consider the part they play in increasing the extent of the cortex.

(3) The third of the partly natural, partly arbitrary portions into which we are dividing the cortical jacket is found between the green, succulent cells (*pa*) of the cortex proper (which we have just been considering), and the proper cambium, *Ca*, and it may be regarded as

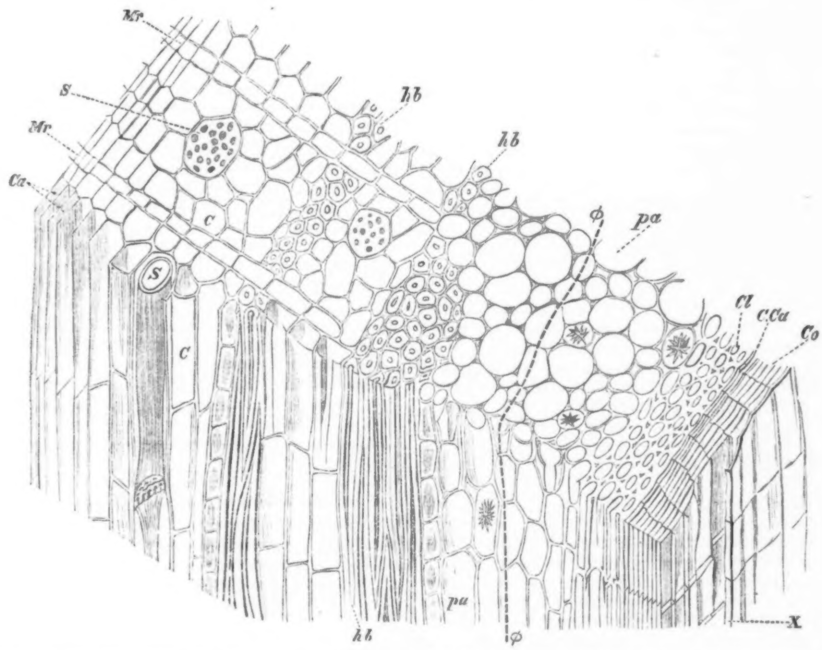


FIG. 20.—A piece of the cambium and cortical jacket of a young oak, at the end of the first year. It may be regarded as consisting of three parts, in addition to the cambium (*Ca*). Beginning from the outside, we have: (1) cork-cells (*X*), formed from the cork-cambium (*C.Ca*): the cells developed on the inside of the latter (*Cl*) are termed collenchyma, and go to add to the cortex. (2) The cortex proper, consisting of parenchyma-cells (*pa*), some of which contain crystals. (3) The inner or secondary cortex (termed *phloem* or bast), developed chiefly by the activity of the cambium (*Ca*): this phloem consists of hard bast fibres (*hb*), sieve-tubes (*S*), and cells (*c*), and is added to internally by the cambium (*Ca*) each year. It is also traversed by medullary-rays (*Mr*), which are continuations of those in the wood. The dotted line (φ) in the cortical parenchyma indicates where the new cork-cambium will be developed: when this is formed, all the tissues (e.g. *pa*, *Cl*), lying on the outside of the new cork will die, and constitute (together with the cork) the true *bark*.

entirely formed directly from the cambium-cells. These latter, developed in smaller numbers on the outside, towards the cortex, than on the inside, towards the wood, undergo somewhat similar changes in shape to those which go to add to the wood, but they show the important differences that their walls remain unlignified, and for the most part very thin and yielding, and retain their living contents. For the rest, we may neglect details and refer to the illustration for further particulars. The tissue in question is marked by *S*, *c*, *hb* in the figure, and is called *phloem* or bast.

A word or two as to the functions of the cortex, though the subject properly demands much longer discussion. It may be looked upon as especially the part through which the valuable substances formed in the leaves are passing in various directions to be used where they are wanted. When we reflect that these substances are the foods from which everything in the tree—new cambium, new roots, buds, flowers, and fruit, &c.—are to be constructed, it becomes clear that if any enemy settles in the cortex and robs it of these substances, it reduces not only the general powers of the tree, but also—and this is the point which especially interests us now—its timber-producing capacity. In the same way, anything which cuts or injures the continuity of the cortical layers results in diverting the nutritive substances into other channels. A very large class of phenomena can be explained if these points are understood, which would be mysterious, or at least obscure, otherwise.

Having now sketched the condition of this cortical jacket when the branch or stem is still young, it will be easy to see broadly what occurs as it thickens with age.

In the first place, it is clear that the continuous sheet of cork (*Co*) must first be extended, and finally ruptured, by the pressure exerted from within: it is true, this layer is very elastic and extensible, and impervious to water or nearly so—in fact it is a thin layer or skin, with properties like those of a bottle cork—but even it must give way as the cylinder goes on expanding, and it cracks and peels off. This would expose the delicate tissues below, if it were not for the fact that another layer of cork has by this time begun to form below the one which is ruptured: a cork-forming layer arises along the line ϕ, and busily produces another sheet of this protective tissue in a plane more or less exactly parallel with the one which is becoming cracked. This new cork-forming tissue behaves as before: the outer cells become cork, the inner ones add to the green succulent parenchyma-cells (*pa*). As years go on, and this layer in its turn splits and peels, others are formed further inwards, and if it is remembered that a layer of cork is particularly impervious to water and air, it is easy to understand that each successive sheet of cork cuts off all the tissues on its exterior from participation in the life processes of the plant: consequently we have a gradually increasing *bark* proper, formed of the accumulated cork-layers and other dead tissues.

A great number of interesting points, important in their proper connections, must be passed over here. Some of these refer to the anatomy of the various "barks"—the word "bark" being commonly used in commerce to mean the whole of the cortical jacket—the places of origin of the cork-layer, and the way in which the true bark peels off: those further interested here may compare the plane, the birch, the Scotch pine, and the elm, for instance, with the oak. Other facts have reference to the chemical and other substances found in the cells of the cortex, and which make "barks" of value commercially. I need only quote the alkaloids in Cinchona, the fibres in the Malvaceæ, the tannin in the oaks, the colouring-matter in *Garcinia* (gamboge), the gutta-percha from *Isonandra*, the ethereal oil of cinnamon, as a few examples in this connection, since our immediate subject does not admit of a detailed treatment of these extremely interesting matters.

The above brief account may suffice to give a general idea of what the cortical jacket covering our timber is, and how it comes about that in the normal case the thickening of the cylinder is rendered possible without exposing the cambium and other delicate tissues: it may also serve to show why bark is so various in composition and other characters. But it is also clear that this jacket of coherent bark, bound together by the elastic sheets of cork, must exert considerable pressure as it reacts on the softer, living, succulent parts of the cortex, trapped as they are between the rigid wood cylinder and the bark; and it is easy to convince ourselves that such is the case. By simply cutting a longitudinal slit through the cortex, down to near the cambium, but taking care not to injure the latter, the following results may be obtained. First, the bark gapes, the raw edges of the wound separating and exposing the tissues below; next, in course of time the raw edges are seen to be healed over with cork—produced by the conversion of the outer cells into cork-cells. As time passes, provided no external interference occurs, the now rounded and somewhat swollen cork-covered edges of the wound will be found closing up again; and sooner or later, depending chiefly on the extent of the wound and the vigour of the tree, the growing lips of the wound will come together and unite completely.

But examination will show that although such a slit-wound is so easily healed over, it has had an effect on the wood. Supposing it has required three years to heal over, it will be found that the new annual rings of wood are a little thicker just below the slit; this is simply because the slit had released the pressure on the cambium. The converse has also been proved to be true—*i.e.* by increasing the pressure on the cambium by means of iron bands, the annual rings below the bands are thinner and denser than elsewhere.

But we have also seen that the cambium is not the only living tissue below the bark: the cortical parenchyma (*pa*), and the cells (*c*) of the inner cortex (technically the phloem) are all living and capable of growth and division, as was described above. The release from pressure affects them also; in fact, the "callus," or cushion of tissue which starts from the lips of the wound and closes it over, simply consists of the rapidly growing and dividing cells of this cortex, *i.e.* the release from pressure enables them to more than catch up the enlarging layer of cortex around the wound.

An elegant and simple instance of this accelerated growth of the cortex and cambium when released from the pressure of other tissues is exhibited in the healing over of the cut ends of a branch, a subject to be dealt with later on; and the whole practice of propagation by slips or cuttings, the renewal of the "bark" of Cinchonas, and other economic processes, depend on these matters.

In anticipation of some points to be explained only if these phenomena are understood, I may simply remark here that, obviously, if some parasite attacks the growing lips of the "callus" as it is trying to cover up the wound, or if the cambium is injured below, the pathological disturbances thus introduced will modify the result: the importance of this will appear when we come to examine certain disturbances which depend upon the attacks of Fungi which settle on these wounds before they are properly healed over. In concluding this brief sketch of a large subject, it may be noted that, generally speaking, what has been stated of branches, &c., is also true of roots; and it is easy to see how the nibbling or gnawing of small animals, the pecking of birds, abrasions, and numerous other things, are so many causes of such wounds in the forest.

H. MARSHALL WARD.

(*To be continued.*)

NOTES.

On Friday, the 23rd inst., Sir Henry Roscoe drew attention in the House of Commons to the Woolwich regulations, the mischievous nature of which we have repeatedly exposed. Sir Henry Roscoe was cordially supported by Sir Lyon Playfair; and Mr. Stanhope, we are glad to say, dealt with the subject in a fair and conciliatory spirit. He promised to discuss the matter with men of science, and the result, we may hope, will be that new regulations will soon be drawn up, securing that scientific candidates shall not be placed at a disadvantage as compared with students of language and literature.

In replying to Sir Henry Roscoe, Mr. Stanhope made a statement to the effect that the regulations now in force for Sandhurst, which were issued in 1884, were recommended by upwards of fifty head masters. We have before us the Report of the Head Masters' Conference for 1883, in which the recommendations of their Committee are printed, and these recommendations differ in certain important respects from the regulations actually adopted by the War Office. The head masters appear, from their suggestions, to have desired to retain a more important place for Latin and Greek than those subjects occupy in the War Office regulations; and they also attached a higher value to higher mathematics. On the other hand, they placed modern languages and experimental science on a lower but relatively less unequal footing than the War Office has done. Although, therefore, in consequence of the position of classics, the actual value of science was, on the whole, perhaps not better under the head masters' suggestions than under the regulations issued by the War Office, it is hardly correct to speak of the head masters as having recommended a scheme of which the predominating fault is, as

we think, the undue difference in the marks allotted to modern languages as compared with the experimental sciences. Moreover, even if Mr. Stanhope were right, it would not follow that the head masters contemplated the application of their suggestions in all respects to the scientific branches of the Army, since the needs of those branches are so obviously different in certain matters. We quite recognize the necessity pointed out by the Secretary of State for War, that the system of the Royal Military Academy (Woolwich) and that of the Royal Military College (Sandhurst) should be as much as possible assimilated to each other. But for that very reason the needs of the Woolwich cadets in the case of science should have been more carefully considered in the framing of the Sandhurst regulations. No one will contend that scientific capacity is a bad thing for a Sandhurst cadet, and since it is admittedly of direct and very great importance to secure scientific capacity on the part of Woolwich cadets, it appears reasonable that, in the case of science subjects, the needs of the Woolwich system should be chiefly regarded, if in this respect the two systems must be made similar.

TEN Fellows of the Royal Society have died in less than four months—a large number when we take into account that the annual death-rate is barely fifteen. Six out of the ten gave an average age of seventy-nine.

THE annual general meeting of the Chemical Society was held yesterday. Mr. Crookes, F.R.S., the President, read a report on the state of the Society, and an address on elements and meta-elements. The medal founded, for triennial award, by Dr. Longstaff, was conferred on Dr. W. H. Perkin, F.R.S. The President, in presenting the medal, expressed the pleasure he felt in thus testifying, in the name of the Society, to the value of Dr. Perkin's interesting and important researches on the magnetic rotary polarization of compounds in relation to their chemical constitution. Mr. Crookes also took the opportunity of congratulating Dr. Longstaff on the fact that although on the eve of his eighty-ninth birthday he is still hale and hearty.

THE half-yearly general meeting of the Scottish Meteorological Society was held yesterday in the hall of the Royal Scottish Society of Arts, Edinburgh. In their Report the Council state that, in addition to the routine work of the Office, the Secretary's time has been occupied with the preparation of the Report on the Ben Nevis observations from the opening of the Observatory in November 1883 to the end of December 1887, and in seeing these observations through the press. The work, which is to appear as an extra volume of the Transactions of the Royal Society of Edinburgh, is in a state of forwardness, the whole of the observations proper of the Observatory being now through the press. The Council also note that the physical and biological researches have been conducted on the *Medusa* during the winter months with characteristic vigour, and with a success so great as to point to the solution of the questions raised by the herring and salmon fisheries, while at the same time an entirely new light has been cast on the circulation of the water in our fresh and salt water lochs, and generally on the problem of oceanic circulation.

AN influential Committee has been formed at Edinburgh for the purpose of collecting subscriptions for a memorial of the late Prof. Kelland. An appeal has been issued to his former students and others, and it ought to meet with a prompt and generous response. Prof. Kelland, as the Committee remind those whom they have addressed, was not only an excellent and most successful teacher of mathematics, loved and honoured by the students of forty sessions at the University of Edinburgh, but one of the most effective recent promoters of the cause of education in Scotland. The precise nature of the memorial will to some extent depend upon the amount subscribed; but it will be essentially a foundation bearing the name of Kelland, such as a Scholarship, or even a special Lectureship, in connection with the Chair of Mathematics at the University of Edinburgh.

THE Irish Exhibition, which is to be held at Olympia, Kensington, from June 4 next to October 27, ought to be one of very great interest. The intention is that the English public shall have an opportunity of obtaining a clear view of the predominant industries of Ireland. It is also proposed to exhibit some of her historical and antiquarian treasures. The profits are to be given in aid of Irish technical and commercial schools.

THE eighth German Geographentag, which was to have been held at Berlin in April, has been postponed. The Committee, in announcing this decision, explain that the festivities which might, as usual, be connected with the meeting would not be in accordance with the feeling excited in the capital by the death of the Emperor William.

THE *Standard* of Wednesday, March 21, printed some extracts from the letters of Cowper, the poet, which may serve to show that the climate of England has not deteriorated, bad as it has lately been. In a letter dated March 19, 1788, Cowper writes to his friend Bagot:—"The spring is come, but not that spring which our poets have celebrated. So I judge, at least, by the extreme severity of the season—sunless skies and freezing blasts, surpassing all that we experienced in the depth of winter. How do you dispose of yourself in this howling month of March? As for me, I walk daily, be the weather what it may, take bark, and write verses. By the aid of such means as these I combat the north-east wind with some measure of success, and look forward—with the hope of enjoying it—to the warmth of summer." On May 6 he says to Lady Hesketh:—"I am just recovered from a violent cold, attended by a cough. I escaped these tortures all the winter; but whose constitution or what skin can possibly be proof against our vernal breezes in England? Mine never were nor will be." Yet only three weeks afterwards (May 27) he exclaims to the same correspondent:—"How does this hot weather suit thee, my dear, in London? As for me, with all my colonnades and bowers, I am quite oppressed by it." It would be interesting if some one could provide particulars as to the weather of any of the former '88 years.

THE *American Meteorological Journal* for February devotes an article to the works of Prof. William Ferrel, now seventy-one years of age. His first meteorological papers were published in the form of essays in 1856, and were reprinted and extended, under the title of "Motions of Fluids and Solids on the Earth's Surface," as one of the professional papers of the Signal Service. In this paper the explanation of the trade winds is altogether different from that usually given. His latest contribution—"Recent Advances in Meteorology" (see NATURE, vol. xxxvi. p. 255)—is the best summary of the principles and results of meteorology in existence. Ferrel's views received considerable attention in France soon after publication, but in this country and in America they have only attracted notice more recently. His mathematical papers on the motions of the ocean are not less important than those on the motions of the atmosphere. The article is accompanied by a good portrait of Prof. Ferrel.

WE have received from Dr. Van der Stok the rainfall observations made in the East Indian Archipelago during the year 1886. Observations are now taken at 102 stations, several additions having been recently made, including an important station on the Key Islands, in longitude 132° 45′ E.; the district now represented extends over 37° of longitude. The data published include the monthly and yearly values for the year 1886, and the means for a number of years, the number of days of rainfall, and the greatest falls in twenty-four hours. The value of the work

would be much enhanced by the addition of charts showing the distribution in space and time, and by some discussion of the results. It has been shown by M. Woeikof that the rainfall of stations close together differs materially. For instance, at Batavia the proportion of rainfall in the wettest and driest months is 8 to 1, while at Buitenzorg, only 25 miles distant, the proportion is only 2 to 1. The work contains a short account of the position of every station.

THE Central Physical Observatory of St. Petersburg has published a memoir on the rainfall of the Russian Empire (506 pp. 4to) with an atlas. The data used in the calculations are brought down to the year 1882, and include observations taken at 450 places, embracing altogether 3112 years. The tables contain individual monthly and yearly values, and the means for the whole period, rainfall frequency, and maximum falls in twenty-four hours. The influences of the form of gauge and exposure on the amounts of rainfall, and of the method of reckoning days of rain, are fully discussed. The amount taken as representing a rainy day is ·004 inch, while in England it is ·01 inch. It is shown that the difference in the methods of counting rainy days materially interferes with the calculations based upon rainfall frequency.

A SERIES of highly interesting experiments upon the vapour-density of ferric chloride have lately been completed by Drs. Grünewald and Victor Meyer. The chlorides of aluminium and indium have already been shown by Nilson and Pettersson, and by V. and C. Meyer respectively, to possess the molecular formulæ $AlCl_3$ and $InCl_3$; it therefore became most important to determine, if possible, whether the molecule of the corresponding chloride of iron possessed, as has been so generally supposed, the constitution Fe_2Cl_6, or $FeCl_3$. The pure ferric chloride for use in the experiments was obtained by gently heating fine iron wire in a stream of dry chlorine gas and re-subliming the product, thus obtaining the salt in beautiful hexagonal plates, exhibiting a fine green colour by reflected, and a purple tint by transmitted light. The first determination was carried out in a bath of vapour of boiling sulphur (448° C.). At this temperature, the lowest at which vapour-density estimations are possible, the volatilization is very slow, but occurs without the slightest decomposition. And yet the vapour-density obtained was considerably lower than that required by the formula Fe_2Cl_6, showing that at no temperature does ferric chloride possess the molecular formula Fe_2Cl_6, but must of necessity consist of molecules corresponding to the simpler formula $FeCl_3$. On repeating the determinations at higher temperatures in baths of phosphorus pentasulphide (518°) and stannous chloride (606°), and in a platinum apparatus heated in a Perrot furnace to temperatures of 750°, 1050°, and 1300°, the numbers obtained gradually approached the vapour-density of $FeCl_3$, the only unfortunate circumstance being that decomposition into ferrous chloride and chlorine occurred as the temperature was increased. However, on repeating the observations in an atmosphere of chlorine, results almost identical with the former ones were obtained; hence there can be no doubt that the true formula of ferric chloride is not Fe_2Cl_6, but $FeCl_3$. It follows from this as a matter of course that the former view as to the tetrad nature of iron must be laid aside. It will be of great interest, in view of this somewhat unexpected result, to learn the results of the determinations of the vapour-density of the lower chloride of iron, which, we understand from Prof. Meyer, are being undertaken by Profs. Nilson and Pettersson.

A THIRD edition of "Practical Amateur Photography," by Mr. C. C. Vevers, has just been issued. This little manual is intended to serve as a text-book for the beginner and a handy work of reference for the advanced photographer, and care has been taken to make it eminently practical.

AN interesting book on "Tank Angling in India," by Mr. H. Sullivan Thomas, has been published at Madras and in London (Hamilton, Adams, and Co.). Anglers in India will find in the little work—in which there are some fairly good illustrations—an immense amount of information about paste-baiting, live-bait picketing, live-bait with a float, worm and prawn fishing, localities suitable for tank-fishing, stocking ponds, the mainspring of fish-life, and names, description, and habitat of fish.

IN No. 124 of the Proceedings of the Royal Society of Edinburgh (session 1886–87) many valuable papers are printed. Among the contents we may note: the sense of smell, being Part III. of Prof. Haycraft's treatise on "The Objective Cause of Sensation"; on transition resistance at the surface of platinum electrodes, and the action of condensed gaseous films, by Mr. W. Peddie; researches on the problematical organs of the Invertebrata, by Dr. A. B. Griffiths; the salinity and temperature of the Moray Firth, and the Firths of Inverness, Cromarty, and Dornoch, by Dr. H. R. Mill; on the minute oscillations of a uniform flexible chain hung by one end, and on the functions arising in the course of the inquiry, by Dr. E. Sang; notes on the biological tests employed in determining the purity of water, by Dr. A. W. Hare; glories, halos, and coronæ seen from Ben Nevis Observatory, extracts from log-book, by Mr. R. T. Omond; on glories, by Prof. Tait; rectilineal motion of viscous fluid between two parallel planes, by Sir W. Thomson; and the thermal windrose at the Ben Nevis Observatory, by Mr. A. Rankine.

AT a recent meeting of the Wellington (New Zealand) Philosophical Society a paper was read by Mr. E. Tregear on "The Origin of Fire" according to Polynesian folk-lore. Mr. Tregear read from Sir George Grey's work the Maori legend of the procuring of fire from the old fire-goddess Mahuika by the hero Maui who had the power of becoming a bird at will, and compared this with the Samoa version in which the fire-deity is a male person, from whom Maui procures fire, having vanquished him in a personal encounter. In the legend of another of the islands the place of Mahuika as fire-deity is taken by the great Polynesian god Tangaroa. From the fact that in these legends the path by which fire was reached was always downwards into the centre of the earth, Mr. Tregear suggests that it was probable that the ancestors of the Polynesians had experience of natural fire drawn from volcanic sources, but to Maui is due the discovery in Polynesia of fire by friction. With regard to Maui himself there is great difficulty in the parent-names. The assumption by him at will of the form of the dove or of the hawk is consistent with the belief in the ancient world of the various shapes assumed by deities when desirous of accomplishing their purposes. The "seed of fire," an expression used in traditions for the inflammable nature of certain kinds of timber, was a common idiom in ancient Continental nations. Fire-worship continued to have its devotees in Europe until comparatively recent times; and the sacred fire was always "new fire" which had not previously been used for any purpose, being kindled by friction. A legend is preserved in Eastern Polynesia of the descent of the Maori people from a race whose name is the same as that of the fire-kindling instrument used in India, and it is remarkable that the deity who forges the thunderbolts in India is probably identical in name with the thunder-god of the Maoris.

DR. GEORGE M. DAWSON has contributed to the Transactions of the Royal Society of Canada (vol. v. section 2, 1887) a valuable series of notes and observations on the Kwakiool people of Vancouver Island. Referring to the question as to the best means of doing good service to the Kwakiool, Dr. Dawson says it is primarily essential to establish among them

industries which will remove the temptation now felt to drift to the larger settlements and towns. The Kwakiool, with other Indians of the coast, already cultivate in a desultory manner small crops of potatoes, on such minute patches of open ground (generally the sites of old villages) as are to be found along the shore. Their bent, however, is not that of an agricultural people, and the densely-wooded character of their country calls for labour, herculean in proportion to the unsystematic efforts of these people, before it can be cleared and reclaimed for agriculture on any large scale. They are excellent boatmen and fishermen in their own way, and Dr. Dawson has no doubt that under favourable conditions they would readily learn to build boats, make nets, and cure fish in such a manner that the product would be marketable. To effect these objects the most essential step, in Dr. Dawson's opinion, is the establishment of industrial schools, where the younger people may be separated from their old associations and instructed in various callings appropriate to their condition and surroundings.

WE have received the Report of the Rugby School Natural History Society for the year 1887. This is the twenty-first issue. The editors point out that owing to various causes a perhaps unusually large number of the meetings were taken up with lectures. Among the contents are two exceptionally interesting papers: one on "Specialization," by Mr. E. Solly, and one on "Natural History in Southern Germany," by Mr. E. E. Austen.

MR. E. STANFORD has issued a pamphlet, by Mr. F. A. Velschow, of Copenhagen, on "The Natural Law of Relation between Rainfall and Vegetable Life, and its Application to Australia." The object of the paper is to show why, in the author's opinion, the regularity of the downpour of rain "depends directly on one particular quality appertaining to vegetable life." He also undertakes to prove that "vapour rarefies the atmosphere instead of increasing its specific gravity, as is now supposed."

THE last Calendar of the Imperial University of Japan, to which we have already briefly referred, shows in a very striking manner how the Japanese are beginning to rely upon themselves for instruction in matters relating to higher education. The following figures will show to what extent the Japanese now avail themselves of European assistance in their University:—(1) Law Department: 19 professors, assistants, and lecturers, of whom 5 are foreigners; (2) Department of Medicine: 53 professors and assistants, of whom 2 are foreigners; (3) Engineering Department: 33 professors, assistants, and lecturers, of whom 4 are foreigners; (4) Literature Department: 19 professors and lecturers, of whom 6 are foreigners; (5) Department of Science: 25 professors and assistants, of whom 2 are foreigners. The academical and other qualifications of the Japanese professors and lecturers appear in most cases to be all that could be expected from men holding their positions. The distribution of the foreign professors and lecturers in the University is, we believe, as follows: eight British, eight Germans, two Frenchmen, and one American. Not many years ago a large majority of the *employés* of the University of Tokio, as it was then called, were Americans; and of the present number of foreigners the majority appear to be employed in teaching foreign systems of law and foreign languages. We notice the appointment for the first time of a Professor of Sanitary Engineering, wherein the Japanese University is in advance of nine-tenths of the educational institutions of the West. It is also curious to notice that the Professor of Japanese Philology and Literature is an Englishman.

ELLIS'S "Irish Education Directory and Scholastic Guide" for 1888 has just been issued. The publication of the volume has been delayed in consequence of the many important changes made in the regulations of the medical licensing bodies in Ireland. During the past year the work has been carefully revised, and it contains full information as to the Irish Universities and professional schools, and the institutions of Ireland for promoting intermediate and primary education. There are also complete alphabetical lists of Irish colleges and schools, and copious alphabetical and classified indices.

THE examination papers set in 1887 in connection with the Royal University of Ireland have been published in a separate volume as a supplement to the University Calendar for the year 1888.

ACCORDING to *Allen's Indian Mail*, the principle of payment by results in the primary schools, has not been altogether successful in India. Last year it proved a failure in Kachar, and this year it is having its final trial in Assam. The teachers in charge of certain selected schools were offered their choice of fixed salaries or payment by results, and if they did not work the latter system successfully they were to revert to the former. The rules for payment by results have recently been revised, larger rewards being offered, and the scheme has been opened to all primary schools.

ON Monday a deputation representing Islington, Hackney, and Stoke Newington, waited upon Mr. Anstie, Charity Commissioner, to confer with him about a proposed scheme of Technical Institutes for the North of London. Mr. Anstie was reminded that the Commissioners had suggested to a previous deputation that St. Pancras, Islington, Hackney, and Stoke Newington should combine in order to formulate an educational scheme which would benefit the North of London. Since that time three of the parishes—Hackney, Islington, and Stoke Newington—had met, but St. Pancras had declined to join them, and they now desired to know what assistance they could get out of the City Parochial Funds for their scheme. The deputation said it would be difficult to raise money, but, supposing that they raised £60,000 in Islington and Hackney, could the Charity Commissioners promise them one-half of that amount? Mr. Anstie replied that the Charity Commissioners' proposal to South London was to contribute pound for pound, to be applied rather to permanent endowments than to pay any preliminary expenses. The Commissioners were very anxious in any scheme that was proposed that provision should be made for children between the ages of 13 and 16 to continue their instruction, and they particularly wished to benefit the poorer classes. In fact, they were bound to do so under the provisions of the Act. If St. Pancras stood outside, then the Commissioners would have to treat with the three parishes alone. He urged them very strongly to use every effort to get as much money as possible. The Commissioners would look most favourably upon a scheme which contained in it the promise of the largest contributions.

DURING the approaching summer a new branch of the London Geological Field Class will make a detailed study of the Chalk formation under the direction of Prof. H. G. Seeley, F.R.S. The other branch under the same direction will follow the course of former years by investigating the principal geological features in the neighbourhood of London. Full particulars can be had by intending students on application to Messrs. G. Philip and Son, 32 Fleet Street, and from many booksellers in the suburbs.

THE additions to the Zoological Society's Gardens during the past week include a Shining Parrakeet (*Pyrrhulopsis splendens*) from the Fiji Islands; two Banded Grass Finches (*Poëphila cincta*); two Bicheno's Finches (*Estrelda bichenovii*) from Queensland; two Mandarin Ducks (*Æx galericulata*) from China, purchased; a white-fronted Lemur (*Lemur albifrons*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

The Pulkowa Catalogue of 3542 Stars for 1855.—Dr. Backlund has given in the "Mélanges Mathématiques et Astronomiques" of the St. Petersburg Academy, tome vi., pp. 563-99, a comparison of the star places of the Pulkowa Catalogue of 3542 stars for 1855, with those of the other Pulkowa star catalogues, including the unpublished one for 1875 by Herr Romberg, as well as with the catalogues of Becker, Boss, and Resphigi. This catalogue, which forms part of vol. viii. of the Pulkowa observations, contains the mean places of 3542 stars observed with the meridian-circle of that Observatory during the years 1840-69. It includes all the Bradley stars north of S. Decl. 15°, with the exception of the Pulkowa fundamental stars, which have not been included because the catalogue-places depend on their positions as determined with the transit-instrument and vertical circle. And as the definitive positions of the present catalogue depend on the two catalogues of fundamental stars for 1845 and 1865, it appears that the system of the catalogue for the epoch 1855 will be practically identical with that of the mean of the two catalogues above mentioned. Dr. Backlund's comparisons give a very favourable view of the accuracy with which the relative positions of the stars have been determined, the probable error of an R.A. in the 1855 catalogue being $\pm$ 0^s·034 for a star south of N. Decl. 30°, and of a declination $\pm$ 0″·30; but they also show that the problem of the determination of absolute positions is in a far less satisfactory state. A further comparison of the Pulkowa 1855 catalogue has been made by Herr Seyboth (*Astr. Nach.* 2808), the catalogue with which it has been compared being that of the Cape Observatory for 1880. The agreement appears to be as close as could be expected considering the unfavourable position at either Observatory of several of the stars used; the Pulkowa star places south of the equator show, however, some discordance from those obtained at the Cape as also from those of Boss's standard catalogue. From a comparison of the fundamental stars only, Herr Seyboth finds for the probable error of the Cape places $\pm$ 0·021s. in R.A., and $\pm$ 0·38s. in Decl.

The Constant of Precession and the Proper Motion of the Solar System.—The completion of Auwers' re-reduction of Bradley's observations, and of the definitive catalogue based thereupon, taken together with the catalogue of 3542 stars and the two fundamental catalogues referred to in the preceding note, has furnished M. L. Struve with the means for a very important investigation, which he has recently published in vol. xxxv. of the *Mémoires* of the Imperial Academy of St. Petersburg. The epoch for Bradley's catalogue being 1755, and the mean date of the three catalogues just mentioned, 1855, M. Struve had at his disposal the places of all Bradley's stars north of S. Decl. 15° for two epochs a century apart. The differences of these places would be due to a combination of three causes: the actual proper motions of the stars, the movement of the solar system, and the error in the constant of precession employed; and they therefore furnish the means of determining both the true value of the precession constant and the direction and rapidity of the motion of translation of the solar system. In his discussion of his materials, M. Struve has followed the method adoped by Sir G. Airy in his treatment of the same problem (Memoirs R.A.S., vol. xxviii.), and determined all his unknowns at the same time. As after excluding all those stars which rest upon but one observation of Bradley, together with a few others omitted for special reasons—seven for their large proper motion,—there still remained 2509 stars, with 2181 proper motions in R.A., and 2345 in Decl., without some method of grouping, the equations of condition would have been too numerous for manipulation. M. Struve has therefore marked off seven zones, each 15° in breadth, and divided these by lines of right ascension into 120 spherical trapezia of nearly equal areas. Each group has been weighted according to the number of the stars it contains, and also according to their magnitudes, so as to reduce the influence of the brighter stars. The solution of the equations of condition by the method of least squares shows very nearly the same correction to the adopted constant of precession,—that of Prof. O. Struve, of 1841, viz. 50″·3798,—from the proper motions in right ascension as from those in declination, the resulting value for the constant being 50″·3514, not so small a value as Nyrén's, 50″·3269, but smaller than those of Bessel, Dreyer, and Bolte. The equating of X, Y, and Z to zero in the normal equations gives a result substantially the same, and proves that the constant can be considered as independent of the motion of the solar system.

For the speed of translation of the solar system, M. Struve finds $q = + 4''\cdot3642$; for the co-ordinates of the apex of the motion, $A = 273° 21'$, and $D = + 27° 19'$. Comparing the various determinations which have been made by other astronomers, he is disposed to adopt as a mean position of the apex—$A = 266°\cdot7$, $D = + 31°\cdot0$. For q, the displacement of the sun in 100 years as seen from an average star of the sixth magnitude, a number of investigators, O. Struve, Dunkin, Gyldén, and Mädler, have found values not greatly differing from 5″; but others, Ubaghs, Airy, Rancken, and Bischof, obtain very different results, varying from $q = 1''\cdot45$ by Ubaghs, to $q = 49''\cdot5$ by Bischof. Taking 0″·011 as the mean parallax of a star of the sixth magnitude, $q = 5''$ would represent an annual motion of about five radii of the earth's orbit, or a velocity of a little over 15 miles per second. It is clear, however, that we are yet far from being in a position to regard these estimates of velocity as more than provisional.

The chief difficulty in these investigations lies in our ignorance of the actual distances of the stars from us, and even of their relative distances. M. Struve has assumed the following mean values of ρ—the distance of the star from the sun—for each order of magnitude, the sixth magnitude being taken as unity:—

m.		m.	
1	... 0·13	5	... 0·70
2	... 0·23	6	... 1·00
3	... 0·36	7	... 1·49
4	... 0·51	8	... 2·25

and adopting 8″ for the secular proper motion of a sixth magnitude star, the scale represents to some extent the proper motions actually observed. M. Struve has also discussed the question of the rotation of the entire sidereal system in the plane of the Milky Way, but his results do not afford any support to the hypothesis, and it has been neglected in the general investigation. At the end of the memoir M. Struve has given the means for the calculation of the general and planetary precessions, together with their secular variations. An appendix furnishes a list of those Bradley stars for which the Pulkowa catalogues gave proper motions sensibly different from those deduced by Auwers from the Greenwich and Berlin observations.

Comet 1888*a* (Sawerthal).—Dr. B. Mattheissen gives (*Astr. Nach.* No. 2830) the following ephemeris from Finlay's elements for this object:—

For Berlin midnight.

1888.		R.A. h. m. s.	Decl. ° ′	Log *r*.	Log Δ.	Brightness.
April	3	22 13 45	7 35·9 N.	9·8821	0·0728	0·83
	5	20 12	9 40·7			
	7	26 36	11 39·3	9·9035	0·0934	0·68
	9	32 55	13 31·7			
	11	39 8	15 18·4	9·9267	0·1134	0·56
	13	45 17	16 59·5			
	15	51 21	18 35·7	9·9507	0·1328	4·46
	17	22 57 19	20 6·9			
	19	23 3 11	21 33·5 N.	9·9749	0·1513	0·38

The brightness on February 18 has been taken as unity.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1888 APRIL 1-7.

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

***At Greenwich on April* 1**

Sun rises, 5h. 36m.; souths, 12h. 3m. 45·5s.; sets, 18h. 32m.: right asc. on meridian, 0h. 44·9m.; decl. 4° 49′ N. Sidereal Time at Sunset, 7h. 14m.

Moon (at Last Quarter April 3, 13h.) rises, 23h. 28m.*; souths, 4h. 2m.; sets, 8h. 30m.: right asc. on meridian, 16h. 41·5m.; decl. 17° 59′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. and declination on meridian. h. m.	° ′
Mercury..	5 0 ...	10 24 ...	15 48 ...	23 5·3 ...	7 48 S.
Venus.....	5 0 ...	10 28 ...	15 56 ...	23 9·1 ...	6 54 S.
Mars......	19 34*...	0 59 ...	6 24 ...	13 38·1 ...	7 32 S.
Jupiter....	23 25*...	3 38 ...	7 51 ...	16 18·1 ...	20 23 S.
Saturn....	11 26 ...	19 25 ...	3 24*...	8 7·6 ...	20 49 N.
Uranus ...	18 42*...	0 18 ...	5 54 ...	12 57·7 ...	5 25 S.
Neptune..	7 22 ...	15 3 ..	22 44 ...	3 44·9 ...	18 8 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

April.	h.	
1 ...	0 ...	Mercury at greatest distance from the Sun.
2 ...	21 ...	Venus at greatest distance from the Sun.
4 ...	13 ...	Uranus in opposition to the Sun.

Saturn, April 1.—Outer major axis of outer ring = 42″·8; outer minor axis of outer ring = 15″·5: southern surface visible.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′			h. m.	
U Cephei	0 52·4 ...	81 16 N. ...	Apr.	2,	4 43	*m*
			,,	7,	4 22	*m*
R Lyncis	6 52·1 ...	55 29 N. ...	,,	2,		*M*
R Canis Minoris...	7 2·5 ...	10 12 N. ...	,,	5,		*m*
R Canis Majoris...	7 14·5 ...	16 12 S. ...	,,	3,	21 15	*m*
S Canis Minoris ...	7 26·6 ...	8 33 N. ...	,,	5,		*m*
R Virginis	12 32·8 ...	7 36 N. ...	,,	7,		*M*
δ Libræ	14 55·0 ...	8 4 S. ...	,,	3,	23 22	*m*
U Ophiuchi... ...	17 10·9 ...	1 20 N. ...	,,	1,	1 35	*m*
			,,	6,	2 11	*m*
X Sagittarii... ...	17 40·5 ..	27 47 S. ...	,,	1,	4 0	*M*
T Herculis	18 4·9 ...	31 0 N. ...	,,	1,		*m*
β Lyræ...	18 46·0 ...	33 14 N. ...	,,	6,	0 0	m_2
R Lyræ	18 51·9 ...	43 48 N. ...	,,	2,		*m*
η Aquilæ	19 46·8 ...	0 43 N. ...	,,	2,	3 0	*M*
T Capricorni ...	21 15·8 ...	15 38 S. ...	,,	4,		*M*
δ Cephei	22 25·0 ...	57 51 N. ...	,,	3,	1 0	*M*
R Lacertæ	22 38·3 ...	41 47 N. ...	,,	7,		*M*

M signifies maximum; *m* minimum; m_2 secondary minimum.

Meteor-Showers.

	R.A.	Decl.	
Near ν Virginis	175° ...	7° N. ...	Bright; slow.
,, ε Delphini	305 ...	12 N. ...	Bright; slow.

THE ROYAL METEOROLOGICAL SOCIETY'S EXHIBITION.

FOR several years past the Royal Meteorological Society has organized an Exhibition of Meteorological Instruments in connection with its ordinary meeting in March. The first Exhibition, which was held in 1880, was of a general character; the subsequent ones, however, have been devoted to the following special subjects, viz. hygrometers, anemometers, travellers' instruments, thermometers, sunshine recorders and radiation instruments, barometers, and marine meteorological instruments.

The subject selected for this year's Exhibition was atmospheric electricity, including new meteorological instruments. The Exhibition was held in the rooms of the Institution of Civil Engineers, 25 Great George Street, Westminster, from March 20 to 23, and was of a most interesting character. The catalogue embraced 155 exhibits, which were arranged under the following heads:—Electrometers, lightning conductors, lightning protectors for telegraph purposes, objects damaged by lightning, &c.; alleged thunderbolts, new instruments, photographs of flashes of lightning, and photographs, drawings, &c.

The Astronomer-Royal exhibited all the apparatus for atmospheric electricity which was formerly in use at the Royal Observatory, Greenwich. These instruments were mounted so as to show the manner in which they were actually arranged for observation.

The Kew Committee also exhibited a number of electrometers which were employed by Sir Francis Ronalds at the Kew Observatory from 1843 to 1851. These are fully described in the Report of the British Association for 1844. Several forms of Thomson's portable electrometer were also shown. The electricity in this instrument is collected by means of a burning fuse at the extremity of a vertical wire. Prof. F. Exner, of Vienna, sent his portable apparatus for the determination of the normal potential in the open air and while travelling.

Numerous patterns of lightning conductors were exhibited by Messrs. J. W. Gray and Son, Messrs. R. Anderson and Co., Messrs. John Davis and Son, and also by the Lightning Rod Conference. Models of churches, houses, chimney-shafts, &c. showed the systems adopted for securing protection from damage by lightning. Messrs. Siemens, Brothers, and Co., also exhibited their apparatus for testing the efficiency of lightning conductors.

The Postal Telegraph Department showed a number of lightning protectors which are used for protecting telegraph instruments.

The Exhibition contained many objects damaged by lightning, including lightning conductors, telegraph instruments and line wire, and portions of trees struck by lightning. The most interesting exhibit, however, was that showing the clothes of a man torn off his body by lightning on June 8, 1878, while standing under a tree. These comprise a flannel jacket, flannel undervest, trousers, stockings, garters, boots, and watch; also a portion of the bark from the tree.

A valuable collection of meteorites was also shown, the specimens being from various parts of the world, and one showing the Widmanstätten figures. A number of alleged "thunderbolts" were also exhibited. These were of an amusing character; the specimens being in reality nothing more than a large nodule of sandstone, a cannon-ball, a piece of coal, clinkers, &c. Mr. Symons, at the meeting of the Society, showed that these were really of a terrestrial, and not a celestial, nature.

One of the special features of the Exhibition was the very interesting collection of more than fifty photographs of flashes of lightning which have been collected from all parts of the world. These show that lightning does not take the zigzag path as depicted by artists and painters. The lightning really takes a very sinuous and sometimes erratic path. Some of the photographs had been enlarged specially for the Exhibition, and showed up to great advantage. In some cases the photographs showed the lightning to be not merely a line of light, but to have a perceptible breadth, somewhat resembling a piece of tape waved in the air. A large number of the photographs were taken in London during the great thunderstorm of August 17, 1887. One of the photographs taken by Mr. E. S. Shepherd shows the remarkable phenomenon of a *dark* flash.

Mr. Symons exhibited three diagrams of lightning made by Mr. James Nasmyth, F.R.S., in 1856, showing (1) Nature's lightning; (2) painter's lightning; and (3) forked lightning. On comparing these drawings with the photographs of lightning, it is at once apparent what a keen eye Mr. Nasmyth must have had, for the agreement is exceedingly close.

Several new meteorological instruments were exhibited. Mr. W. H. Dines showed a maximum wind pressure anemometer. This has a circular plate, which is always kept face to the wind, at the back of which is a vessel containing shot. The pressure of the wind forces back the plate, and allows shot to fall from the higher to the lower part of the vessel. As soon as the weight of the shot in the lower vessel is equal to the whole pressure on the plate, the plate resumes its normal position, and the opening through which the shot falls is closed. The weight of the shot in the lower vessel gives the maximum pressure since the instrument was last read. Mr. G. H. Larkins showed some rainband spectroscopes with Tripe's arrangement. The improvements in this instrument over the ordinary form of direct-vision spectroscope are: (1) that it gives uniform light and dispersion, and also better definition of the lines; (2) that as the slit is of uniform width, observations made with this form of instrument are comparable with each other; and (3) that the focussing tube can be fixed by a revolving clamp and kept ready for use.

Dr. Marcet exhibited Prof. Colladon's instrument for illustrating the formation of waterspouts. This consists of a large glass vessel, at the bottom of which has been scattered some dust somewhat heavier than the water. The motion given to a handle turns a wheel which imparts to the water a circular motion. The dust is then drawn up from the bottom in a column, and looks exactly like a waterspout or a sand pillar.

Mr. J. B. Jordan showed one of his new pattern photographic sunshine recorders (in which he now obtains a straight record instead of a curved one), and also that devised by Dr. J. Maurer, of the Swiss Central Observatory, Zurich.

Mr. G. M. Whipple exhibited his repeating cloud camera, which has been designed for obtaining a series of four photographs of the same cloud at short intervals of time, in order to show rapid changes of form.

Numerous photographs of damage by lightning were shown, as well as several records of atmospheric electricity taken at the Greenwich and Kew Observatories during thunderstorms and snowstorms. Messrs. Norman May and Co., exhibited two beautiful photographs taken from the top of the Worcestershire Beacon (1390 feet above sea-level), about 700 feet above the general level of the fog which covered the whole of the surrounding country, on January 12 last. Above the fog there was bright sunshine.

Mr. R. Abercromby and Mons. C. Moussette each exhibited some very fine photographs of clouds; and Mr. J. S. Dyason showed a number of sketches of skies in colour.

WILLIAM MARRIOTT.

THE BOTANICAL DEPARTMENT, NORTHERN INDIA.

UP to the year 1874-75, the Botanical Gardens at Saharanpur and the Botanical Officer in charge of them were Imperial, *i.e.* were under the control of the Supreme Government. In 1875, under the scheme of decentralization by which the independent powers of local Governments were considerably increased, the charge of the Saharanpur (Botanical) Institute became provincial, and passed under the authority of the Lieutenant-Governor of the North-Western Provinces and Oudh.

In 1887 the subject of reorganizing the Botanical Survey in India was taken up in connection with the memorandum, dated February 10, 1885, by Mr. Thiselton Dyer, Director of the Royal Gardens, Kew, and after consultation with the Government of the North-Western Provinces and Oudh and the Superintendents of the Botanical Gardens, Howrah and Saharanpur, the Government of India determined that the most important step which it was desirable to take in order to bring the hitherto unexplored regions of India under botanical survey was to expand the circle, for the botanical investigation of which the Saharanpur Officer was responsible, so as to bring the greater part of Upper India within the sphere of his duties. In order to effect this object it became necessary to restore the Saharanpur Botanist to his former position as an Imperial officer. A further reason for this change was found in the necessity for maintaining, at the disposal of the Government of India, the services of a Botanical Officer with a specially trained staff for the purpose of accompanying expeditions in the neighbourhood of or beyond our north-western frontier. These duties have now been attached to Mr. Duthie, the officer who holds the Saharanpur appointment.

The transfer took effect from April 1, 1887. But the Gardens, with the assistant, Mr. Gollan, who was brought out in 1879, were not placed under Imperial control, but still remained provincial. The Imperial Botanist is therefore now divorced from the Curatorship of the Gardens, which has passed, under the general control of the Director of the Provincial Department of Agriculture, into the hands of the former assistant. The Botanical Officer retains his occupation of the house and Botanical Museum (with the Herbarium), but has no longer any connection with the practical management of the surrounding gardens.

The Botanical Officer retains under his control the whole of the native staff connected with the Museum and its Herbarium, as well as the native artist (now drawing Rs. 100 a month), who was trained at the Bombay School of Art specially for the Saharanpur Institution.

THE NEW SIBERIAN ISLANDS.[1]

THE Expedition of MM. Bunge and Toll, who have explored the lower Yana and the islands of New Siberia during the last two years, was sent out by the Russian Academy of Sciences. Hedenstrom's description of the masses of petrified wood which is found on these islands, and the information gathered from the hunters as to the richness of the archipelago in remains of Quaternary mammals, were the chief inducements for sending out the Expedition.[2] The Expedition consisted of Dr. Bunge, who had just terminated his two years' stay at the Sagastyr Polar station at the mouth of the Lena; Baron Toll; two Cossacks, four Yakuts, and two Tunguses. After having explored the region at the mouth of the Yana during the summer of 1885,[3] and spent the winter at the Kazatchie settlement, twenty miles to the south of Ust-Yansk, the Expedition started in the spring for the New Siberian Islands, and for better exploring them divided into two parties. Dr. Bunge undertook the exploration of the southern islands of the archipelago, and especially of the small Lyakhoff Island, while Baron Toll explored the northern islands (Kotelnyi, Thaddeus, and New Siberia), usually called the Anjou Islands.

Owing to some misunderstanding Dr. Bunge did not find his reindeer on the small Lyakhoff Island, which was his chief station; and, until June 14, he was compelled to limit his explorations to a few excursions only. He saw large flocks of ducks coming from the north—that is, from what is an open sea on our maps, while several species of *Larus* and *Totanus* came from the south. As a rule, few birds cross to Little Lyakhoff Island in their migrations; only geese come by the end of June, and as they moult on the shores of the small lakes and ponds of the island, they are killed in great numbers by the hunters.

The winter lasts on the Little Lyakhoff Island until the first part of June, and returns again in October. On October 16 the frost was already -37° C., but even during the summer 10° C. over zero is considered a very hot temperature; and in July there were thirteen days with snow, fifteen with fog, four with rain, and one snowstorm.

And yet organic life develops with astonishing rapidity. The first flowers were seen on June 11, and Dr. Bunge's collection of phanerogams numbers seventy species; but all plants are dwarfs, hardly reaching a few inches, while the soil, even in the best situated places, thaws only to the depth of 16 inches. The water of the small ponds is so much warmed by the rays of the sun, that temperatures of from 10° to 16° C. were observed, and therefore worms and Crustacea rapidly develop in the ponds. The insects are few; even the mosquitoes do not plague men and cattle as they do on the continent; still, two butterflies were caught. As to mammals, herds of reindeer come every year from the continent to the islands, but in smaller numbers than formerly; they are followed by wolves. The snow fox is very common, but the common fox and hare are exceedingly rare visitors to the islands. The Polar bear has become of late very rare, and hunters attribute this to the fact that the ice has remained unbroken for several yeas past. They affirm that the ice around the coasts has not moved since the year when Nordenskiöld sailed through in the *Vega*, and Dr. Bunge doubts whether it will soon be possible to repeat the same journey.

The chief interest of the island is in its masses of fossil bones buried in the frozen soil. Bones of the mammoth, rhinoceros, *Bos moschiferus*, two other species of *Bos*, several species of *Cervus*, very many bones of *Equus*, and several others, were found, and brought in by Dr. Bunge. The rocks of which the island is built are granite and sedimentary rocks without fossils.

Baron Toll's expedition was much richer in results. It appears from his surveys that the Kotelnyi Island extends much farther east than is shown on our maps, and that it is connected with Thaddeus Island by a sandy beach. It would be most interesting to know how far this circumstance is due to the upheaval of the islands, which is sure to go on like the upheaval of all the northern coast of Siberia. But the most important discovery is, that the masses of fossil wood which were found on Thaddeus Island proved to be Tertiary, and not Quaternary, as has hitherto been supposed. They belong to layers of Tertiary coal, and fossil *Sequoiæ* were found amidst them. We have thus a new proof that the great Tertiary continent which possessed a warm climate, well known from Oswald Heer's description, included not only Greenland, Spitzbergen, and Novaya Zemlya, but also the New Siberian Archipelago, more than 90° of longitude to the east of Novaya Zemlya. Geology must explain the existence of this warm climate beyond the 75th degree of latitude, at a period so closely preceding that of the glaciation of the northern hemisphere.

Finally, Baron Toll, after having made rich zoological, botanical, and palæontological collections—Silurian, Devonian, and Triassic deposits being found on the Kotelnyi Island,—reached the northern extremity of the island under the 76th degree of latitude, and thence he saw the land which was seen eighty years ago by Sannikoff, and has since periodically appeared on, and disappeared from, our maps. It exists, and it is situated nearly a hundred miles (150 versts) due north, off the northern extremity of the Kotelnyi Island.

If we take into account the facts that there are serious reasons for admitting the existence of a land to the north of Novaya Zemlya,[1] and that the existence of Sannikoff's Land is now again

[1] See the Preliminary Report by A. Bunge in the *Izvestia* of the Russian Geographical Society, vol. xxiii. 1885, 5th fascicule.

[2] See Dr. Schrenck's "Zur Vorgeschichte der von der Akademie ausgerüsteten Expedition," in *Beiträge zur Kenntiss des Russischen Reichs*, 3te Folge, 1886.

[3] The account of the explorations in the Yana region has appeared in the *Beiträge zur Kenntniss des Russischen Reichs*, 1886.

[1] See the "Report of the Commission for an Arctic Expedition" in the *Izvestia* of the Russian Geographical Society, 1871.

confirmed, we must recognize that the discovery of Franz Joseph's Land was but a first step towards the discovery of the Arctic archipelagoes which undoubtedly exist under and within the 80th degree of latitude. P. A. K.

EARTHQUAKES IN THE LEVANT.[1]

THE Island of Zante, in the Ionian Group, to the north-west of the Gulf of Arcadia, is a centre from which no fewer than seven submarine cables radiate, and Mr. Forster has taken advantage of his position as manager of the station to make some interesting observations of the connection between interruptions of the cables and the occurrence of earthquakes, which are more frequent, he says, in the Levant than in any other part of the world, except Japan. The notes of what he has himself observed are valuable and suggestive, but unfortunately he has made them a peg on which to hang a theory that the "true and only reason for seismic disturbances" is that landslips and subsidences occur in ocean beds. Soundings of the bed of the Mediterranean, made chiefly in the interest of cable-laying, have brought to light extraordinarily rapid variations of depth. In one case, Mr. Forster tells us, the repairing ship of his company found a difference of 1500 feet between the bow and stern soundings. "We know of mushroom-shaped mountain ranges, abrupt and precipitous table-lands, immense marginal shelves and overhanging cliffs. . . . We know by soundings that many of these tottering masses are hanging over precipices from 3000 to 5000 feet in height, and that the erosion of the water at the base of the inverted cone-shaped rocks eventually causes them to slide over." Mr. Forster admits that a secondary cause of earthquakes may be "explosions owing to the filtration of water through the crevices and chasms that a denudation of so large an extent must necessarily cause." He has done good service in drawing attention to a cause of earthquakes which seismologists may have been disposed to under-rate, but he overstates his case outrageously in making this explanation cover every example. "I am prepared, of course," he says, "to encounter a torrent of objections to the acceptation of my theory as the sole cause of seismic disturbances" (*sic*), and this is well.

By way of supporting the theory he has written a long, rambling, inconsequent pamphlet, the manner and matter of which we may illustrate by quoting a paragraph that is neither better nor worse than its neighbours:—

"If, therefore, we are to believe that the process of cooling our planet, which began so many thousands of centuries ago, is gradually and surely condensing the nucleus of liquid or solid fire in its centre, it is reasonable to assume that the bed of the Mediterranean, by virtue of its more recent formation, should be more subject to the effects of the contraction of the upper crust than other parts which have gone through these periods already; because it is evident that the contraction which originally commenced began equally so over the whole surface of the earth's sub-crust, and was, through some unknown reason, abruptly suspended in certain parts which only subsided and very suddenly when the cooling action was once more renewed."

Or this, which the author himself puts in italics:—

". . . *The severity of the concussion is always precisely proportionate to the bulk of the falling mass, the depth of its fall, and the nature of the matter constituting it, and on to which it falls. . . .*"

We commend the following to the attention of electricians, as coming from one of their own number:—

"By 'freeing' a cable, it is understood that the end opposite to the testing-station is detached from the apparatus and left free in the air; and, provided the cable be electrically perfect, no deflection of the magnetic needle will appear at the testing-office when the cable is joined up through a delicate galvanometer to 'earth.' If, however, the cable thus insulated is lying near to or in the direct radius of a volcano, or near to any hot springs, the increased temperature would cause a thermopile to be set up, and by induction through the insulating material its presence would be plainly manifest."

[1] "Seismology: a Paper on Earthquakes in General; together with a New Theory of their Origin, developed by the Introduction of Submarine Telegraphy." By W. G. Forster, Manager and Electrician to the Eastern Telegraph Company, Zante. Dedicated, by Special Authority, to His Majesty George I., King of the Hellenes. Pp. 68. (London: Waterlow and Sons, 1887.)

The fact that in certain earthquakes the author made this test and found no current, is used as an argument to show the "absolutely local nature" of what in another place he calls the "*centri*" of the shocks.

What is of real value are his positive observations of certain cases where the rupture of a cable or the production of a bad fault in it took place at the moment an earthquake occurred, and of cases where, when the cable came to be repaired, the contour of the ocean bed was found to have undergone a distinct change, the cable being, in more than one instance, actually buried below the new surface. The great earthquake which destroyed Filiatra in August 1886, shook the telegraph office at Zante so sharply that the clerk rushed out. On returning to his Morse instrument, he found, by the paper band which was still running, that a message coming from Candia had been interrupted at the time of the shock, and tests taken immediately after showed a dead break 23 miles from Zante. Other cables, following a more northerly course, were not disturbed. In another instance a cable was broken at once in two places, 2 miles apart, apparently by a subsidence of the ground between. Once, when the Zante-Trepito cable was broken by an earthquake 7 miles from Zante, the repairing ship discovered "that the break had occurred in a depth of about 2000 feet of water, where about 1400 feet originally existed, and it was impossible to haul in the broken end, firmly jammed down by the mass which had fallen over and upon it."

If Mr. Forster had contented himself with telling the story of facts like these, which have come within his own observation, the seismologist would have felt nothing but gratitude. But these grains of wheat are only reached after wading through an intolerable deal of wordy chaff. The gist of the pamphlet is to be found in the last fifteen or twenty pages, and we advise the reader who wishes to save his patience to go to them at once. We conclude by quoting an interesting passage where Mr. Forster describes two natural phenomena of Cephalonia, about which one would like to know more:—

"Not far from Lizuri, which is on the western side of the Bay of Argostoli, is a moving rock which, unchanged by the roughest or the calmest sea, rocks to and fro with the regularity of a pendulum. It is separated from a fixed mass of rock against which it opens and shuts in its perpetual motion; at one time it will jam a knife placed in the crevice, from which, in a few seconds, extraction is impossible, whilst the next moment you can easily insert your bent hand when its maximum aperture has been reached. This phenomenon has been carefully examined by many scientific men; divers have been sent below to ascertain if it be the result of a detached rock from a neighbouring cliff having fallen on to another, and thus becoming very finely balanced, as all logan stones usually are. However, it was not only shown to be a perfectly solid rock, but it does not require the motion of the water to sway it, as so often we find it erroneously stated, the motive power for swaying it being furnished from an absolutely inexplicable cause. Nearly opposite to this rocking stone the other remarkable phenomenon is to be found, consisting of a body of water, equal in bulk to about half a million gallons per day, running in from the sea at four points on the coast somewhat rapidly for a certain distance until it gradually becomes sucked into the earth and disappears. By conducting the water into an artificial canal for a few yards, and by collecting the four points of supply into one, enough motive power is obtained to drive two mills. The stream, after being thus utilized, is allowed to follow its own course, and is lost among the rocks. . . . [It] has no visible outlet."

THE MINERAL CONCRETION OF THE TEAK TREE.[1]

AT the last meeting of the Nilgiri Natural History Society Mr. Lawson showed a specimen of a whitish mineral substance found in a teak tree growing in the Government Plantation at Nilambúr. This peculiar secretion is not altogether unknown to officers in the Forest Department, and its composition has on more than one occasion been investigated by chemists.

In 1870 the fact of calcareous masses occurring in timber was brought to the notice of the Asiatic Society of Bengal by Mr. R. V. Stoney, who stated (*vide* P.A.S.B., May 1870, p. 135) that many trees in Orissa had pieces of limestone or calcareous tufa

[1] A Paper read by David Hooper at a meeting of the Nilgiri Natural History Society, Ootacamund, November 7, 1887.

in their fissures, but principally Asan (*Terminalia tomentosa*, W. and A.), Swarm (*Zizyphus rugosa*, Lam.), Sissu (*Dalbergia sissu*, Roxb.), and Abnus (*Diospyros melanoxylon*, Roxb.).

In 1880, Mr. V. Ball, in making a geological survey in the Central Provinces, met with this concretion, and thus alludes to it in his "Jungle Life in India":—"Some white marks on the cut stumps of an Asan tree caught my eye, and these on examination proved to be sections or laminæ of calcareous matter which alternated with the ordinary rings of woody growth. The rocks about were gneisses and schists, and I could discover nothing in the soil to account for the peculiarity. In some cases irregularly shaped pieces seven inches long by two inches thick were met in the trunks at a height of about six feet from the ground. By the natives the lime is burnt and used for chewing with *pan*. On examination it was found there was no structure in these masses which would justify a conclusion that they had been formed by insects. Some included portions of decayed wood seemed to be cemented together by the lime."

Major-General Morgan, late Deputy Conservator of Forests, Madras, speaks of it in the following terms in his "Forestry of Southern India":—"It is a curious fact that in the Wynaad, though there is no free lime in the soil, yet Teak (*Tectona grandis*) and Blackwood (*Dalbergia latifolia*), if wounded near the ground, contrive to absorb large quantities of lime. It may be seen, incrusting the tree on the surface as far as four feet in height, from three inches to a foot in width, and two or three inches in thickness. The lime is so hard that it destroys circular saws, and the Carumburs use it for chewing with betel."

Abel, in 1854, thus described it: "The wood of teak, which grows in the South of India and other tropical countries, frequently exhibits cracks and cavities of considerable extent lined with a white crystalline deposit consisting chiefly of hydrocalcic orthophosphate, $CaHPO_4, H_2O$, with about 11·4 per cent. ammonio-magnesium phosphate" (Chem. Soc. Q.J. xv. 91.)

This white deposit in the wood of teak has also been examined by Thoms, who found it to consist of monocalcic orthophosphate, $CaHPO_4$ ("Landw. Versuchs. St." xxii. 68, xxiii. 413). More recently still Prof. Judd has found in teak a specimen of crystalline apatite, a well-known mineral containing a large proportion of calcium phosphate.

"The formation of this deposit indicates that the wood itself must contain a considerable quantity of phosphoric acid, and the analysis shows this is really the case, as the ash of teak wood is composed as follows:—

CaO	MgO	FeO	K_2O	Na_2O	SiO_2	SO_3	P_2O_5	CO_2	Cl
31·35	9·74	0·80	1·47	0·04	24·98	2·22	29·69	0·01	0·01

The percentages of carbon and hydrogen are higher than in most woods, and this together with the richness in calcium phosphate and silica may perhaps account for the great hardness of teak" (Watts' "Dict. Chemistry," 3rd Supp. p. 1894).

The sample from Nilambúr was in the form of a rounded flattened cake about ten inches in diameter and two or three inches in thickness; dirty white in colour, with a rough gritty surface. A sample was made for analysis by breaking off portions from different parts of the cake and reducing the whole to a fine powder. The powder examined under the microscope was mainly in an amorphous condition similar to prepared chalk, with a dark-coloured gummy matter, and a small quantity of crystalline quartz sand. The following is the composition:—

Calcium carbonate	70·05
Tricalcic orthophosphate	2·89
Quartz sand	9·76
Organic matter	14·30
Moisture	3·00
	100·00

The analysis shows that the principal compound is calcium carbonate, and the concretion approaches nearer the chalk or limestone formation than that of the apatite or phosphatic found by other investigators. An examination of deposits from other trees might show greater differences than these, but it seems enough has been done to prove that the calcium element forms the base.

The sand, probably blown up as dust and made to adhere by the organic matter, is a mechanical ingredient. The deposit contained no salts of sodium or calcium soluble in water, nor any ammoniacal compounds; this would stand to reason, as the heavy rain to which this district is subjected would scarcely leave anything soluble on the trees.

A sample of the soil from the Teak Plantations, the same as that in which the ipecacuanha is being cultivated, has also been examined. It is a light reddish brown sandy loam with quartz. In a dry state it contains 79 per cent. of silica and silicates, about 5 per cent. of organic matter, the same of iron oxide and alumina, and 0·217 per cent. lime as oxide.

The scanty amount of lime present in the soil, and the large amount found in the tree, show what an enormous quantity must have been taken up by the sap. I have shown elsewhere that a full-sized cinchona tree contains about ten ounces of lime (as slaked lime), not concentrated by abnormal development in one place, but distributed in all its parts. A teak tree from its size and ash contents would have a much larger supply than a cinchona, and yet, it seems, is able to excrete it in some abundance. In what manner this takes place is not easy to determine. The calcium enters the plant in a soluble form as sulphate. The calcium unites with oxalic and other acids and is precipitated, while the sulphuric acid parts with its sulphur to form organic compounds. A wound in the tree is liable to render these processes abnormal by causing the vegetable acids to ferment by exposure to the air and to yield carbonic acid as one of the products, and this meeting with the calcium in the ascending sap exuding from the wound might convert it into an insoluble calcium carbonate which would harden in the cavity of the tree and form the deposit.

THE NEW YORK AGRICULTURAL STATION.[1]

THE special report of the Director, Dr. E. Lewis Sturtevant, extends over the first fifty-seven of a volume of 480 pages, and within their limits are to be found the general conclusions arrived at during the past year. The remainder of the *brochure* consists of the detailed reports of the horticulturist, the botanist, and the chemist. After an analysis of the rainfall and temperature of 1887, which appear in general climatic conditions to have borne a great resemblance to what we ourselves experienced, the Director calls special attention to the importance of soil moisture, and surface cultivation as a means of conserving it. He shows the vast importance of checking evaporation from the surface by preserving a finely pulverized condition of the top soil. This he calls a "soil mulch," and states that "it protects the capillary outlets from surface exposure."

"The extent of the conservation of water through the prevention of evaporation by cultivation, as measured by the lysimeters in 1885 from May to September inclusive, with a rainfall of 14·42 inches, as between bare soil and cultivated soil, was about 1·4 inch, and as between cultivated land and sod-land about 2·5 inches. The rational direction, therefore, to the farmer for carrying out intercultural tillages must be to use an implement as a means to an end, *i.e.* the maintaining of a mulch of loose soil upon the field. . . . The intercultural tillage should be applied whenever the upper soil has regained, through the effect of rains, its connection with the lower soil, and the capillary tubes become extended to the surface. Following the same line of argument, the evil effects of weeds are attributed to their appropriation and transpiration of moisture from the soil rather than to their robbing the plant of food constituents. This conclusion will be brought home to anyone who notices the dry condition of the soil in near proximity to tree roots."

The remarks upon feeding cattle with a view to milk and to beef production are interesting, but the system of experimenting upon single animals is not to be commended. The conclusion forced upon the Director, that "individuality is sufficient to mask the influence of food," is patent to anyone, and should demonstrate the absolute need of carrying out any feeding experiments upon a large number of cattle simultaneously. Average results may then be expected upon which practice may be based.

The Director pours a flood of cold water upon the system of plot experiments in the field. Under the head of "Conclusions" he says:—"These field trials indicate the utter unreliability of field experiments, and should convince the public of the lack of certainty which attends all general conclusions gained by this process. I trust the time may arrive when this plat work, instead of being forced upon experiment stations, will be condemned." Certainly

[1] Sixth Annual Report of the Board of Control of the New York Agricultural Experiment Station (Geneva, Ontario Co.) for the year 1887.

after obtaining no increase by the application of 1400 pounds of a fertilizer, over what had been obtained from a dressing of 400 pounds per acre, there might appear some cause for complaint. We cannot, however, indorse Dr. Sturtevant's opinions. Plot experiments may be made fairly representative of larger areas, and upon them various treatments of soil and crop may be compared. No doubt great care should be taken in carrying out such experiments; but surely a series of plots of $\frac{1}{4}$, $\frac{1}{10}$, or $\frac{1}{20}$ acre each might be and are made to teach most useful lessons. Dr. Sturtevant might well pause to consider that if such experiments are of no value the value of other experiments might be doubted, and the public, to whom he appeals, might think fit to rescind a grant amounting to £4000 a year for the purpose of carrying out his researches. The volume abounds in tables of analyses of fodder and grain crops. A large portion (200 pages) of the middle is occupied by a descriptive catalogue of varieties of beet, carrot, radish, turnip, onion, celery, spinach, squash, tomato, &c., mostly very wearisome, and savouring more of the catalogue of the seedsman than of the results of scientific work.

Downton. JOHN WRIGHTSON.

SCIENTIFIC SERIALS.

Bulletin de l'Académie Royale de Belgique, January.—Researches on the influence of magnetism and temperature on the electric resistance of bismuth and its alloys with lead and tin, by Ed. van Aubel. These protracted experiments have been undertaken in order to determine the variations of electric resistance due, not only to magnetism and heat, but also to molecular structure, with a view to discovering the causes of the disturbances and completing our knowledge of the phenomena first observed by Hall. In the present paper, a first contribution to the study of the subject, the author deals mainly with the diminution of the electric resistance of bismuth and its alloys under increased temperature. He shows that the anomaly cannot be due to the presence in the metal of foreign elements such as arsenic, tin, lead, or iron. The state of greater or less tension of the bismuth itself also seems to have no influence. But the study of some bismuth wire obtained by the soldering of the filings of this metal under a pressure of several thousand atmospheres constantly exhibits a considerable increase of resistance when the temperature is raised.—Experimental researches on the vision of the Arthropods, third part, by Felix Plateau. This part deals with the vision of caterpillars, and with the *rôle* of the frontal ocelli in the perfect insects. The very numerous experiments here described and carried out under the most varied conditions, tend to the general conclusion that in insects possessing both compound and simple eyes (ocelli), the former are of some service, while the latter are quite useless, and should consequently be grouped in the category of rudimentary or atrophied organs. In the case of caterpillars the vision is defective, not extending distinctly beyond one centimetre, and is supplemented by the antennæ and the fine hairs covering the body. Perfect insects when completely blinded almost invariably fly in a straight line vertically, which, against the opinion of Forel, is attributed to the more intense light of the higher regions, to which the whole surface of the body is susceptible. The primitive "dermatoptic sensation" is revived, and acts in a feeble way as a substitute for the later developed ocular vision of which the animal has been deprived.—On the molecular work of the organic liquids, by P. De Heen. It is shown that the author's formula of 1882, that for the organic fluids belonging to one and the same homologous series the molecular work is fairly constant, has been mainly confirmed by subsequent research.—This number of the *Bulletin* also contains a valuable paper by Louis Henry on the volatility of the carbon compounds, the result of several years' research.

Rivista Scientifico-Industriale, February 29.—On the peronospora of the grape-vine, by Prof. G. Cuboni. The two phases of this disease are fully described for the first time, and the disease itself is carefully distinguished from black-rot and other analogous forms of blight with which it is often confounded. A mixture of sulphur with 3 or 4 per cent. of the sulphate of copper is proposed as the best remedy if applied at an early stage.—Prof. E. Canestrini concludes his experiments on some effects produced by induction sparks. In one instance the leaves of some perennial plants were found to be covered with dark spots similar to those frequently observed on plants struck by lightning. But the results of these researches, like others of a similar kind, have obviously no more than a relative value, depending as they do on the intensity of the induced currents.

Journal of the Russian Chemical and Physical Society, vol. xix. No. 8.—Isomery in the series C_nH_{2n-2}, by A. Favorsky.—On the laws presiding at reactions of direct addition, by J. Kabloukoff.—Short notes by MM. E. Sokoloff, Joukovsky, and Gorboff.—Experimental researches into the oscillations of electrical force in electrolytes, by A. Sokoloff; it is the third of a series of elaborate papers on the subject, especially with regard to the capacities of voltameters.—On the measuring of specific heat by the method of mixtures at a constant temperature, by N. Hesehus.—End of a full bibliography of all books and articles printed in Russia on chemistry and chemical technology during the year 1886.

Journal of the Russian Chemical and Physical Society, vol. xix. No. 9.—On the speed of formation of acetic ethers of monatomic alcohols, by N. Menshutkin, being a first paper of a new series of researches where the compound influence of the surrounding medium in which the reaction is going on has to be studied.—Notes by MM. Matweieff and Spiridonoff.—On the empirical formula of cholic acid, by P. Latchinoff, being an answer to the criticisms against the new formula ($C_{25}H_{42}O_5$) proposed by the author.—On the gelatinous state of albuminoid bodies, by W. Mikhailoff, being the first of a series of papers intended to summarize elaborate researches on the subject, in accordance with the principles laid down by Lieberkühn and his followers.—On the number of parameters which determine the displacement of a kinematic chain, by P. Somoff. Taking up the view of Reuleaux, who recorded each mechanism as a kinematic chain, the author shows the necessity of considering the degree of freedom left to each part of the chain in its displacements in various mechanisms.—On the dependence of the colour of bodies on the angle of incidence of the rays of light, by W. Rosenberg.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 15.—"Report of the Observations of the Total Solar Eclipse of August 29, 1886, made at Grenville, in the Island of Grenada." By H. H. Turner, M.A., B.Sc., Fellow of Trinity College, Cambridge. Communicated by the Astronomer-Royal.

The first part of the paper gives details of the general arrangements made for observation—the selection of a site, the erection of the instruments, and a hut to cover them; and refers to the unfavourable conditions under which the observations were made. The second part gives the results of the observations. These were of two kinds.

(1) Before and after totality the order of appearance and disappearance of a number of bright lines in the spectrum of the chromosphere and inner corona was watched. The lines selected were those observed by Mr. Lockyer in the Egyptian eclipse of 1882, and the observations were undertaken with a view to the confirmation of his results.

The lines are denoted for convenience by small letters as follows:—

	λ.		λ.		λ.
a	4870·4	*e*	4917·9	*h*	4932·5
b	4871·2	*f*	4919·6	*i*	4933·4
c	4890·0	*g*	4923·1	*k*	4956·5
d	4890·4			*l*	4970·0

With this nomenclature, a table given by Mr. Lockyer in a short account of his results (Roy. Soc. Proc., vol. xxxiv., 1883, pp. 291, &c.) shows that lines *g* and *l* are seen by Tacchini in prominences, while *a*, *b*, *c*, *d*, *e*, *f*, and *k* are seen in spots.

Mr. Lockyer saw *g* and *i* 7 minutes before totality,
and in addition *k* and *l* 3 " "
and all the lines 2 " "

In my own observations I saw *g* 3 minutes before totality,
and in addition *i* 40 seconds "

while the moment of appearance of all the lines was indistinguishable from the commencement of totality.

After totality clouds obscured the sun for a short time; but on their clearing the visibility of *g* and *k* was noted; *i* could not be seen.

The three lines *g*, *i*, and *k* were extremely short, and did not

appear to extend beyond the chromosphere before and after totality.

The unfavourable conditions under which the observations were made as compared with Mr. Lockyer's—with a low sun and through passing clouds, and an atmosphere charged with moisture which doubtless diminished the light in this region of the spectrum considerably—perhaps account in some measure for the striking difference in vividness of the phenomena. The solar activity was also much nearer minimum in 1886 than in 1882. As far as they go, however, the observations are confirmatory of Mr. Lockyer's, except in the visibility of the line *k* after totality. This line was not noted before totality, and it is possible that the observation may be spurious, although the evidence for it is as good as that for all the observations, which were found to be generally of a difficult character. The instrument used was a 6-inch refractor by Simms, with a grating spectroscope; the grating being $1\frac{1}{2}$ inch square, ruled with 17,000 lines to the inch. The second order of spectrum was used.

(2) During totality I was directed to look for currents in the corona. I can only report a negative result. The structure of the corona appeared in a 4-inch refractor, with a power of 80, to be radial to the limb throughout, and no striking differences in special localities were noticed.

Appended to the paper are two drawings which do not attempt to give more than the distances to which the coronal rays extended in various directions. One was made by Mr. St. George with an opera-glass, and the other by Lieut. Smith with the naked eye; but in the latter case the observer's eyes had been specially covered fifteen minutes before totality, and the brighter portions of the corona were screened from him by a disk of angular diameter three times that of the moon. He consequently traced the rays much further than Mr. St. George, though, allowing for this difference in conditions, the drawings are fairly accordant.

"On the Ultra-Violet Spectra of the Elements. Part III. Cobalt and Nickel." By Profs. Liveing and Dewar.

The authors compare the results obtained by the Rutherfurd grating which they used in measuring the wave-lengths of the iron lines with those obtained with the larger Rowland's grating used for measuring the wave-lengths recorded in this paper, and find them closely concordant. They next compare the measures of wave-lengths of the cadmium lines obtained by them by means of a plane Rowland's grating and a goniometer with an 18-inch graduated circle with those obtained by Bell with a large concave grating of 20 feet focal length. The result of the comparison is that the plane grating gives measures which agree very closely with those given by the concave grating, while the former gives more light and is better for complicated spectra, such as those described in this paper, because the overlapping spectra of different orders are not all in focus together as they are when a concave grating is used.

The authors give a list of 580 ultra-violet lines of cobalt and 480 lines of nickel. They find a certain general resemblance of the two spectra, but no such exact correspondence as the close chemical relationship of the two metals would render probable. They point out that the coincidences of lines of the two metals are hardly, if at all, more in number than would have been the case if the distribution of the lines had been fortuitous. They give a map of each spectrum to the same scale as Ångström's normal solar spectrum.

Linnean Society, March 15.—W. Carruthers, F.R.S., President, in the chair.—On a ballot being taken, the following were elected Fellows of the Society: Messrs. J. W. Taylor, W. Gardiner, and David Sharp. The following were admitted Fellows of the Society: Messrs. A. G. Renshaw and A. E. Shipley.—Mr. J. Harting exhibited the frontal portion of the skull of a red-deer stag, which, although an adult animal, had never possessed horns, and made some remarks on the occasional occurrence of this abnormality. The stag in question was one which had been shot some years ago by the late Emperor of Germany in the Royal forest of Göhrde, in Hanover. A discussion followed in which the President, Mr. Seebohm, and Dr. Hamilton took part.—The first paper of the evening was then read by Mr. George Massee, entitled "A Monograph of the *Thelophoreæ*," and drawings of several of these Fungi were exhibited. The paper was criticized by Mr. A. W. Bennett and Prof. Marshall Ward.—In the absence of the author, a paper by Mr. E. A. Batters, describing three new marine Algæ, was then read by the Botanical Secretary, Mr. B. Daydon Jackson, who exhibited the drawings made to illustrate the paper. After some critical remarks from the President, Mr. Harting pointed out the indirect influence of the Gulf Stream in causing a deposition of northern sea-weeds upon the north-east portion of the English coast, where some of the species described had been found.

Zoological Society, March 20.—Mr. Henry Seebohm in the chair.—Mr. G. A. Boulenger read a note on the classification of the Ranidæ, in which, after speaking of the difficulty hitherto experienced in dividing this large group satisfactorily, he called attention to Peters's discovery that in certain forms a small additional phalanx is present between the ultimate and what is normally the penultimate phalanx. The author therefore proposed to separate the family Ranidæ into two groups, according to the presence or absence of this peculiar digital structure.—Mr. G. B. Sowerby gave the description of sixteen new species of shells, amongst which were two species of the genus *Lima* from Hong Kong and Japan; a remarkable species of the rare genus *Malletia* from the Bay of Bengal; a very distinct species of *Cypræa* from Japan; and one of the largest species yet known of the genus *Columbella*.—Mr. F. E. Beddard read some notes on a freshwater Annelid, of which he had obtained specimens from a tank in the Society's Gardens. Mr. Beddard referred these specimens to a new species of the genus *Æolosoma*, which he proposed to called *Æ. headleyi*.—Prof. Newton, F.R.S., communicated (on behalf of Mr. Scott Barchard Wilson) the description of *Chloridops*, a new generic form of Fringillidæ, based on a specimen obtained on the west coast of the Island of Hawaii, Sandwich Group, which he proposed to name *Chloridops kona*. Unfortunately the single example yet obtained was of the female sex.

Geological Society, March 14.—W. T. Blanford, F.R.S., President, in the chair.—The following communications were read:—On the gneissic rocks off the Lizard, by Howard Fox, with notes on specimens by J. J. H. Teall. The rocks may be classed under three heads: (1) the coarse gneisses or Mên Hyr type, (2) the light-banded granulitic gneisses or Wiltshire type, and (3) the transition micaceous rocks of "Labham Reefs," type intermediate between (2) and the mainland schists. The first are seen in Mulvin, Taylor's Rock, Man-of-war Rocks, the Stags, Mên Par, Clidgas, Mên Hyr, and Vasiler; the second in Sanspareil, the Quadrant and adjoining reefs, Labham Rocks, &c.; and the third in the Labham Reefs. The inclination of the divisional planes appeared conformable with that of the rocks of the mainland. The gneisses and granulites of several of the islands are traversed by numerous dykes of prophyritic basic rock, seen in Taylor's Rock, Man-of-war Rocks, Sanspareil, Quadrant Rock and Shoals, and Clidgas. These dykes have been disturbed by movements subsequent to their intrusion. They sometimes strike across the foliation-planes of the gneiss, and send veins into the latter rock; at other times the strike is parallel to that of the foliation-planes; the two modes of occurrence are occasionally observable in different portions of the course of the same dyke, *e.g.* in one traversing that part of the Man-of-war group known as the Spire. This dyke is also noticeable from the fact that it appears to be traversed by veins of gneiss. The dykes vary in width from 18 inches to several feet. In his notes on the specimens, Mr. Teall arranges the rocks in four groups. Prof. Bonney spoke in high terms of the value of the work done, as it was in a region accessible with difficulty, which time did not permit him to explore when working at the rocks of the mainland.—The Monian system, by the Rev. J. F. Blake. The reading of this paper was followed by a discussion in which the President, Dr. Hicks, Prof. Hull, and Prof. Bonney took part.

Royal Meteorological Society, March 21.—Dr. W. Marcet, F.R.S., President, in the chair.—The President delivered an address on atmospheric electricity. He first alluded to Franklin's experiments in America in 1752, who succeeded in obtaining the electricity of a storm-cloud by conducting it along the string of a kite sent into the cloud. De Romas, in Europe, repeated the experiment, and, having placed a wire within the twine his kite was attached to, obtained sparks of 9 or 10 feet in length. The characters of the two kinds of electricities were next described—the vitreous or positive, which was produced by rubbing glass, and the resinous or negative, obtained by rubbing sealing-wax or another resinous substance; and it was shown, by bringing suspended balls of pith within the in-

fluence of these electricities, that electricities of different kinds attract each other, and those of the same kind repel each other. De Saussure's and Volta's electroscopes were next described, pith-balls being used in the former and blades of straw in the latter for testing the pressure of electricity. With the object of measuring the force of electricity, Sir W. Thomson's electrometer was mentioned, in which the electricity is collected from the air by means of an insulated cistern letting out water drop by drop, each drop becoming covered with electricity from the atmosphere, which runs into the cistern where it is stored up, and made to act upon that portion of the instrument which records its degree or amount. The atmosphere is always more or less electrical, or, in other words, possessed of electrical tension, and this is nearly always positive; while the earth exhibits electrical characters of a negative kind. The effects of atmospheric electricity were classed by Dr. Marcet under three heads: (1) lightning in thunderstorms; (2) the formation of hail; (3) the formation of the aurora borealis and australis. He explained how clouds acquired their electrical activity by remarking that clouds forming in a blue sky, by a local condensation of moisture, became charged with positive electricity from the atmosphere; while heavy dark clouds rising from below nearer to the earth were filled with terrestrial negative electricity, and the two systems of clouds attracting each other would discharge their electricity, giving rise to flashes of lightning. In some cases a storm-cloud charged with positive electricity would approach the earth, attracting the terrestrial negative electricity, and when within a certain distance shoot out lightning which would apparently strike the earth; but it would just as well have struck the cloud, only there was nothing in the cloud to sustain any damage, while on the earth there were many objects lightning would destroy, to say nothing of its effects upon animal life. Thunder is the noise produced by the air rushing in to fill up the vacuum made by the heat of the lightning flash. There may be sheet lightning, zig-zag or forked lightning, or globular lightning. The latter is particularly interesting from its assuming a spherical form. Illustrations were given of objects struck by lightning, the most remarkable being, perhaps, the clothes of a working man which were torn into shreds, while the man himself was not seriously injured. Dr. Marcet next proceeded to show a flash of lightning, which he produced by throwing on a white screen the image of an electric spark 2 or 3 inches in length, enlarged by means of the lens of an optical lantern; forked lightning, 6 or 8 feet in length, with its irregular zig-zag course, was most clearly demonstrated. After alluding to the protecting power of lightning conductors and their construction, Dr. Marcet explained the formation of hail and waterspouts, and exhibited an instrument by Prof. Colladon, of Geneva, for showing the formation of waterspouts. He concluded his address with a few remarks on the aurora borealis and australis, the formation of which was illustrated by de la Rive's experiment, which consisted of successive discharges of electric sparks through a partial vacuum while under the influence of a powerful magnet; electric sheets of light were seen assuming the form of bands and possessed of a certain rotating motion.—Mr. G. J. Symons, F.R.S., read a short commuication on the non-existence of thunderbolts, and briefly described the history of several so-called thunderbolts, the specimens obtained being of an amusing character, thus clearly showing that they were of a terrestrial and not a celestial character.

EDINBURGH.

Royal Society, February 20.—Sir W. Thomson, President, in the chair.—A preliminary note on the duration of impact, by Prof. Tait, was communicated. The results already obtained were got by means of a roughly made apparatus designed for the purpose of testing the method used. When a wooden block of 10 lbs. mass fell through a height of 18½ inches on a rounded lump of gutta-percha, the time of impact was found to be 0·001 sec., and the coefficient of restitution was 0·26.—A paper on a bathymetrical survey of the chief Perthshire lochs was read by Mr. J. S. Grant Wilson of H.M. Geological Survey. Lochs Rannoch, Tummel, Earn, and Tay, were specially dealt with. In the discussion which followed, Sir W. Thomson remarked that he did not consider that the ice had much to do with the formation of rock basins. Where it found a rock basin already in existence it might increase its dimensions.—Mr. H. M. Cadell, H.M. Geological Survey for Scotland, read a paper, of which an abstract appeared in our last issue (p. 488), on experimental researches in mountain building.—Mr. Peach communicated a paper by Dr. Ernst Stecher on contact phenomena of some Scottish olivine diabases.

March 5.—Mr. J. Murray, Vice-President, in the chair.—Mr. W. E. Hoyle communicated a paper by Mr. D. McAlpine on observations on the movements of the entire detached animal, and of detached ciliated parts of bivalve mollusks, viz. gills, mantle-lobes, labial palps, and foot.—The Chairman communicated a report on the fishes which he had obtained in deep water on the north-west coast of Scotland. The report was drawn up by Dr. A. Günther, F.R.S., Keeper of the Zoological Department, British Museum.—Prof. Haycraft read a paper by Dr. Carlier and himself on the morphological changes which take place in blood during coagulation.—A paper by Prof. Tait on the mean free path, and the number of collisions per particle per second in a group of equal spheres, was communicated. In this paper Prof. Tait cited De Morgan's definition of the term "mean," and pointed out the difference between the mean free path, properly so called, and the quantity to which that name is usually applied.—A preliminary note by the same author on the compressibility of glass at different temperatures was also read. The glass experimented upon was ordinary lead glass. At 8° C. the compressibility per atmosphere is 0·0000027, and increases by 0·00000002 per degree Centigrade of rise of temperature.

March 19.—Sir W. Thomson, President, in the chair.—Mr. George Seton read a paper on illegitimacy in the parish of Marnoch.—Dr. G. Sims Woodhead communicated some notes on the use of the mercuric salts as antiseptic surgical lotions.—In a paper on the effect of differential mass-motion on the permeability of gas, Prof. Tait gave the calculations which he promised in his reply to Prof. Boltzman published in the *Philosophical Magazine*.—The President read the second part of a paper by Mr. J. J. Coleman, on a new diffusimeter, and other apparatus for liquid diffusion, and discussed the determination of diffusivity in absolute measure from Mr. Coleman's experiments.—Sir W. Thomson also read an extract from a letter of the late William Froude to himself, dealing with the soaring of birds. Mr. Froude showed that in all cases soaring is dependent on the existence of upward air currents. In the case of a complete calm at sea, the upward current is produced by displacement as a wave passes underneath.—Mr. W. Peddie read a preliminary note on new determinations of the electric resistance of liquids by a method based upon Joule's law, and which therefore avoids any error which might be caused by transition-resistance or polarization.—Mr. C. A. Stevenson gave a notice of the recent earthquake in Scotland, with observations on those since 1882.

PARIS.

Academy of Sciences, March 19.—M. Janssen in the chair.—On certain points connected with the theory of accidental errors, by M. Faye. It is argued that the arithmetical mean does not necessarily and in all cases give the most probable result. The law of error can be regarded only as a simple approximation to the truth, although so far valuable that it may be freely applied to all sorts of observations and measurements, provided they be exempt from systematic error. The danger lies in excluding all extremes which might have the effect of enabling the observer to draw any conclusion he pleases, or which squares best with some preconceived view. The same subject is discussed in a paper by M. J. Bertrand on the probable value of the smallest errors in a series of observations.—On a point in the theory of the moon, by M. F. Tisserand. The object of these remarks is to determine in Delaunay's theory of the moon the full scope and application of the theorem of the invariability of the great axis of the lunar orbit. The demonstration here induced from Delaunay's method is extremely simple, and leads to some further interesting inductions.—New theory of the equatorial *coudé*, by MM. Lœwy and P. Puiseux. The paper deals with the corrective terms depending on the inner glass and the axis of declination. In a future paper will be given the terms depending on the outer glass, together with the complete formulas of reduction.—On the absorption of saline substances by plants, by MM. Berthelot and G. André. The experiments here described are mainly confined to the sulphate of potassa, and will in future be extended to other substances with a view to elucidate the obscure processes by which plants derive their mineral elements from the soil. The solution of the

soil whence the roots derive the sulphate is shown to remain always richer than the solution penetrating into the vessels of the roots. Thus is confirmed the general law of this class of phenomena, and some important inductions are drawn from it in connection with the formation of the nitrates in certain plants.—On the relations of atmospheric nitrogen with vegetable humus, by M. Th. Schlœsing. Having previously studied the relations of vegetable earth with ammonia, carbonic acid, and oxygen, the author here extends his researches to its relations with atmospheric nitrogen.—On the actinometric observations made at Montpellier during the year 1887, by M. A. Crova. From these observations it appears that the calorific intensity, measured at noon, steadily increased from the beginning of winter nearly to the end of spring, attaining its monthly maximum (1·35 calorie) in May, and its absolute maximum (1·54 cal.) on the 24th of that month. Then it declined rapidly, its mean value during the summer being inferior to the means of other seasons. It rose, fell, and again rose in autumn, during which period it acquired a new maximum of 1·26. These observations confirm the general laws induced from the records of previous years, showing that, although the epochs of maxima and minima may often be exceptionally displaced, the maxima of radiation occur normally in spring, the minima in summer. Tables follow giving the mean annual intensities and other meteorological data for the five years 1883–87.—On the unification of the calendar, by M. Tondini. Reference is made to the recent steps taken by Italy for the purpose of promoting the universal adoption of the Gregorian calendar, which, thanks to the action of England, has already replaced the Chinese system in Japan under almost insurmountable difficulties.—Remarks accompanying the presentation of a model of the Fumat safety-lamp, adapted for use in mines subject to fire-damp, by M. Daubrée. This lamp, which has been for some time in use in the Grand Combe mines, has successfully withstood the severe tests to which it has been subjected by MM. Mallard and Le Châtelier, and seems to answer all the purposes of such an appliance quite as well as any other hitherto devised.—The meridian of Laghwat, by M. L. Bassot. The geodetic junction of Spain with Algeria, completed in 1879, has now been extended to Laghwat, 180 miles south of Algiers, and on the verge of the Sahara. This carries the great meridian for the west of Europe across 28° of latitude, from the northernmost point of Great Britain through France and Spain to about 33° N. latitude, on the confines of the desert. To the triangulation have been attached the astronomic stations Gelt-es-Stel and Laghwat itself, the latitude and longitude and an azimuth for each of these places having been accurately determined.—On the passage of the electric current through sulphur, by M. E. Duter. Sulphur, a very bad conductor at the normal temperature, is here shown to acquire a considerable degree of conductibility when raised to the boiling-point.—On the radiograph, by M. Louis Olivier. The instrument described under this name has been invented by the author as a self-acting recording photometer. At each revolution of the drum it closes an electric circuit, and thus automatically shuts off the luminous action at any desired moment. While serving in a general way as a registering apparatus for light, it is capable of venous applications in photography, meteorology, and physics.—On the hydrate of sulphurated hydrogen, by MM. de Forcrand and Villard. Having already made known the composition of this substance, $HS + 12HO$, and measured its tension of dissociation between $+0·5$ and 29° C., the authors here resume its study for the purpose of more accurately determining this tension at or about the temperature of 0°. This is found to be about equal to atmospheric pressure.—Experimental researches on chronic intoxication by alcohol, by MM. A. Mairet and Combemale. Having previously described the influence of chronic alcoholic intoxication on the nervous and muscular systems, the authors here study its effects on the heart, the respiratory and digestive organs, and the bodily temperature.

BERLIN.

Physical Society, March 2.—Prof. du Bois Reymond, President, in the chair.—Dr. Gumlich spoke on Newton's rings as seen by transmitted light. The speaker had calculated and experimentally verified the formulæ for the rings as seen by transmitted light, in the same way as many years ago Prof. Wangerin had treated the rings when seen by reflected light, and subsequently verified the results of his calculations experimentally in conjunction with Prof. Sohncke. The outcome of Dr. Gumlich's calculation was the same as that of Prof. Wangerin for the rings seen by reflected light. When the light is incident at right angles, the rings are circles lying in one plane: when the angle of incidence is less than a right angle, the rings lie on a surface of extremely complicated shape, which is characterized by a primary ordinate, and an oblique ordinate at right angles to the former, which do not coincide at the point of intersection. By means of an apparatus which the speaker showed and carefully described, he had experimentally tested the accuracy of his calculations, and found them fully confirmed. When the light is incident obliquely, the rings are no longer circles as they are when it falls on to and passes through the medium at right angles, but are now ellipses whose axes bear a ratio to each other which is dependent on the angle of incidence of the light. It was not found possible to obtain any definite results as regards the width of the rings, since this is very largely affected by temperature.—Dr. Sprung reported on a work which had been sent in by Dr. Müller-Erzbach treating of the determination of mean temperature by means of the weight of water which is vaporized. A bulb blown on the end of a glass tube is half filled with water and introduced into a wide-necked flask whose bottom is covered with sulphuric acid. Assuming the truth of Dalton's law of tensions, Dr. Müller has arrived at a formula by means of which the mean temperature of a space can be determined from the mass of water which is vaporized in a given time.—At the end of the meeting Prof. Lampe discussed a reply which had been recently made to a criticism of his on a piece of work done last year by Dr. Häussler, and showed how devoid of foundation the reply was.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

Geography of the British Isles: A. Geikie (Macmillan).—Pubblicazione del Real Osservatorio di Palermo, vol. iii. (Palermo).—Glen Desseray: Principal Shairp (Macmillan).—Die Wechselbeziehungen zwischen Pflanzen und Ameisen im Tropischen Amerika: A. F. W. Schimper (Fischer).—Encyclopædia Britannica, vol. xxiii. (Black).—Disease, its Prevention and Cure: C. G. Godfrey (Grevel).—Untersuchungen über Heterogenese, iii., Dr. A. P. Fokker (Groningen).—Journal of Morphology, vol. i. No. 2 (Ginn, Boston).

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